THE DISTRIBUTION, MOVEMENTS, DEMOGRAPHY, AND HABITAT USE OF THE LITTLE RANCHERIA CARIBOU HERD

Yukon
Renewable Resources

Prepared by:
Richard Farnell &
Janet McDonald

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FINAL REPORT

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RICHARD FARNELL
AND
JANET MCDONALD

YUKON DEPARTMENT OF RENEWABLE RESOURCES
WHITEHORSE, YUKON

Director, Fish and Wildlife Branch

Senior Big Game Biologist

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ABSTRACT

Studies of the Little Rancheria herd (LRH) were carried out between October 1985 and March 1988 to collect data on caribou distribution, movements, demography, and habitat use. A total of 11 caribou (all female) were radio-collared and subsequent surveys found a home range (7356 km^2) that comprises game management subzones 10-29 to 10-32 in Yukon and the northern part of management unit 6-24 in British Columbia. The population size and composition of the herd was estimated using the stratified random quadrat technique in March 1988. The herd numbered 681 $\pm$ 20% (545-817) caribou at the 90% confidence level. Recruitment of 10 month old calves was 18.6% of herd numbers (29.8 calves/100 females) and the sex ratio was heavily skewed against males which represented only 18.7% of herd numbers (29.7 males/100 females). The observed adult natural mortality rate, calculated from the death rate of our small radio-collar sample, was 20.8% and was considered crude for management purposes. The combined annual Yukon-B.C. harvest is roughly 20 caribou or 3% of the population. Analysis of plant composition from fecal samples during winter indicate that LRH caribou are of the 'ground lichen' ecotype and are not limited by the availability of winter forage. Snow conditions on the herd's winter range, as assessed by snow depth sampling and long term records at Watson Lake, are highly variable but mostly critical (60-70 cm.) for caribou. Implications of this study are that cooperative management between Yukon and B.C. is essential to the well being of the LRH, and this must include better documentation of native harvest. The maximum harvest level should not exceed 3% of herd size, the take of which should be split equally between hunters from B.C. and Yukon. Further study of caribou winter range features are needed to provide adequate input to logging plans.

INTRODUCTION

This report summarizes findings from a study conducted between October 1985 and March 1988 to inventory the Little Rancheria caribou herd (LRH). The primary objective of this study was to provide biological data on herd distribution, movements, demography, and habitat use. Information necessary for caribou harvest management and informed land use planning.

Limited background information was available at the beginning of this study. Bergerud (1978) first identified the LRH as a distinct population of woodland caribou (Rangifer tarandus caribou) inhabiting the northern Cassiar Mountains. It was speculated that the herd moved northeast to wintering grounds in the Liard Basin southwest of Watson Lake. Bergerud (1978) calculated from a single census survey in September 1977 that the herd numbered 444 caribou and was declining by 11% annually due to negative recruitment of calves, which constituted 4% of herd numbers. Later, to assess the impact of potential pipeline construction on caribou in the Liard Basin, Eccles (1983) conducted distribution surveys along a proposed (Foothills Pipe Lines Ltd.) pipeline right-of-way, to delineate obvious migratory corridors. It was apparent from these surveys that the pipeline, if built, would encounter an important wintering area for caribou. Eccles (1983) reported that caribou from this wintering area likely range in the adjacent Cassiar Mountains to the southwest during other seasonal periods.

The Yukon Fish and Wildlife Branch focused attention on caribou occupying the Liard Basin during winter for 2 primary reasons:
1) caribou in that area are important to native subsistence hunters from Watson Lake and Lower Post, who stated that numbers had declined in recent years (Dickson Lutz and Peter Stone, pers. comm.).
2) The Liard Basin, the apparent winter range of the LRH, has the highest potential for large scale commercial logging in Yukon (Oswald and Senyk 1977); [Logging is known to have an adverse impact on caribou in more southerly environments, (Stevenson and Hatler 1985, Edmonds and Bloomfield 1984)]. This study was therefore conducted in recognition of the need for improved management of the LRH.

The study was assisted by funds ($4,000) made available by the Province of British Columbia to expand survey efforts to include the range of the Swan Lake caribou herd during winter 1986. This contribution aided in delineating areas used by the LRH in British Columbia and refined our range use pattern analysis.

STUDY AREA

The study area is located in the southeast Yukon and northwestern British Columbia, and corresponds to the home range of the Little Rancheria herd (Fig. 1). It includes the Liard Basin to the north and the Cassiar mountains to the south and west. The study area is roughly 7346 km^2 (2870 mi^2) in size.

Elevations range from 900 meters a.s.l. (3,250 feet a.s.l.) in the Liard Basin lowlands to a maximum elevation of 2,170 meters a.s.l. (7119 feet a.s.l.) in the Cassiar Mountains. The study area is drained by the Liard River and its tributaries, the Rancheria, Little Rancheria and Blue Rivers.

Roughly one-half of the study area lies in the Liard Basin ecoregion (Oswald and Senyk 1977), which is densely forested with closed stands of conifers and hardwoods. White (Picea glauca) and black (Picea mariana) spruce, with a moss or moss-shrub understory, form the climax vegetation on nearly all sites below subalpine. Lodgepole pine (Pinus contorta) is prevalent on plateaus and hills. Balsam poplar (Populus balsamifera) occurs along river terraces, or on river floodplains with willow (Salix spp.) and aspen (Populus tremuloides). Larch (Larix spp.) is common and paper birch (Betula papyrifera) is scattered amid other tree species. The area is characterized by moderately high winter snow accumulations, and meteorological data from Watson Lake indicate an annual precipitation of about 430 mm. Mean annual temperatures range from about -25°C in January to about 15°C in July. The Liard Basin has the highest potential for growing trees in Yukon and some lowland portions are presently being logged. The Liard Basin is also an important wintering habitat of caribou.

The Cassiar mountain region rises gradually from the Liard Basin and consists of moderately high relief where treeless tundra is common. Lower elevations have white/black spruce communities, with some spruce/lodgepole pine stands interspersed. The subalpine areas have alpine fir (Abies lasiocarpa) and shrub/willow communities, while alpine areas have sedge/tussock communities. The undulating plateaus of the Cassiar Mountains are typical summer range habitat for caribou.

Human settlements are peripheral to the study area and include the towns of Watson Lake and Cassiar (Fig. 1). The Alaska and Cassiar Highways are two major transportation corridors that cross portions of the study area.

Little data is available on the occurrence of other ungulates in the study area. During this study we found that moose (Alces alces) were common throughout the area, and moderate numbers of stone sheep (Ovis dalli stonei) occur in scattered groups across the Cassiar Mountains. Potential predators of caribou in the study area include wolves (Canis lupus), grizzly (Ursus arctos) and black bears (Ursus americanus), wolverine (Gulo gulo), lynx (Lynx canadensis), and golden eagle (Aquila chrysaetos).

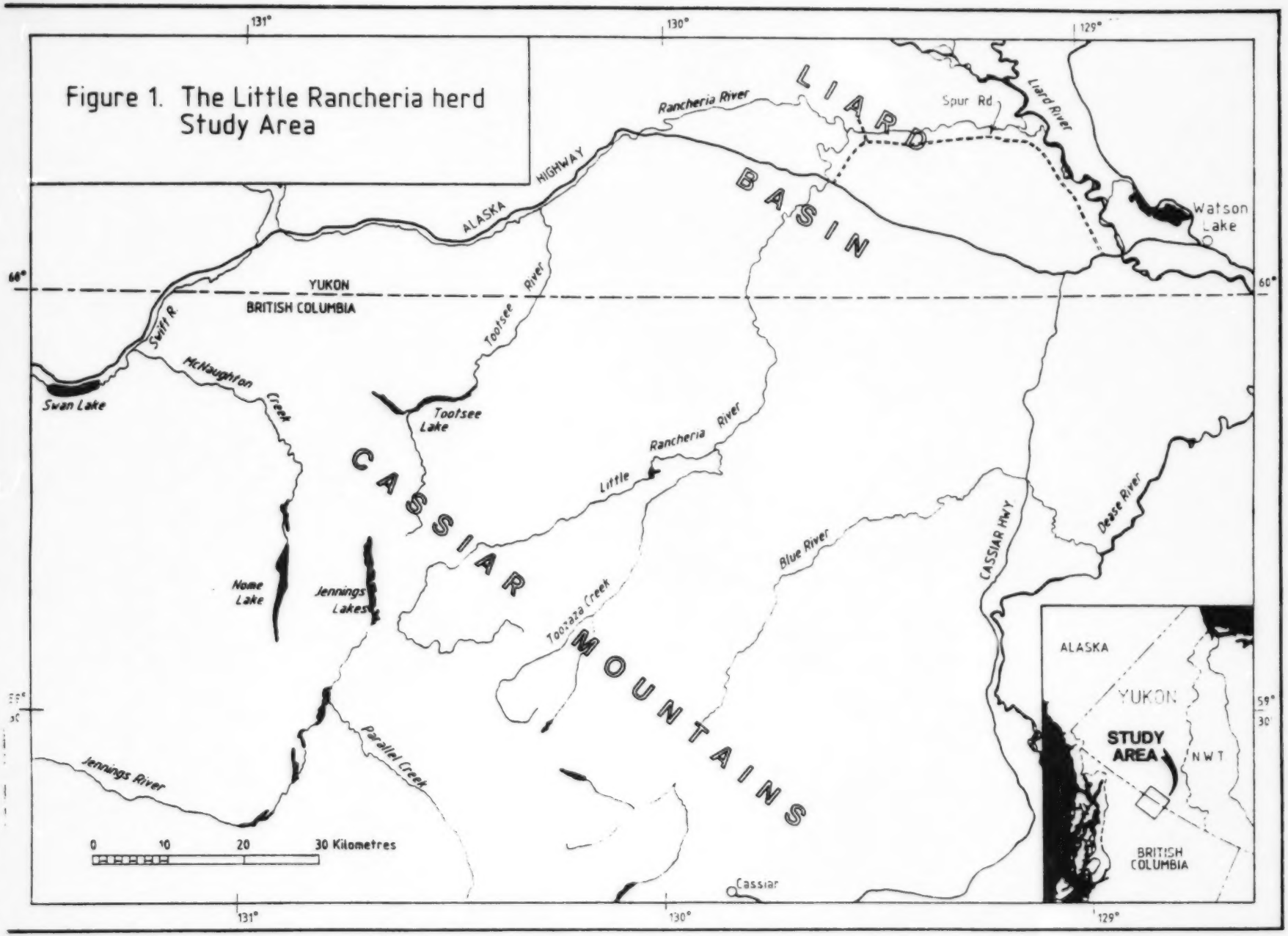


Figure 1. The Little Rancheria herd Study Area

METHODS

SEASONAL MOVEMENTS AND DISTRIBUTION

Capture and Radio-collaring

Caribou were captured using the net-gun capture method (Barret et al. 1982). With one exception all caribou were captured on the winter range (February). The exception was a caribou captured during a post-calving survey in summer (July). We assumed that caribou captured on the winter range would reveal the general seasonal range use pattern for the herd during all periods. We selected female caribou for capture because females retain collars better than males. Neck expansion and contraction in males during the fall breeding season often leads to shed collars.

Radio-collars were constructed of heavy machine belting to which transmitters were attached. All radios contained movement sensitive mortality switches (Telonics Inc., Mesa, Arizona). To aid resightings, a highly visible vinyl covering was sewn to each radio-collar.

Distribution Surveys

To determine LRH distribution 4 life cycle periods were selected for relocation of radio-collared caribou: winter (Feb.), calving (June), post-calving (July), and rut (Oct.). In all, there were 8 relocation surveys flown between June 1985 and February 1987, and one additional survey in March 1988 to aid in censusing the herd (Appendix A). These surveys were flown at high altitude (3000 to 4500 meters a.s.l.) along transects over the entire study area for all periods except winter. During winter, surveys were confined to the Liard Basin area. When relocated, a signal was circled at high altitude and pinpointed to within 7 km^2 on 1:250,000 topographic maps. When a mortality signal was detected, the site was later accessed by helicopter and the cause of death investigated. Caribou tracks in snow were recorded during fall, winter and spring surveys to assist in documenting distribution and movements. Distribution information was also available from composition surveys conducted during post-calving and rut. These surveys included a visual resighting of each radio-collared caribou.

HERD DEMOGRAPHY

Population size

We attempted to census the LRH using the total count method during the rut in October 1985 and 1986. The reliability of this method has proven to be questionable however, since there is no accounting for animals not observed during the survey (Farnell and Gauthier 1988). As additional funds became available at the close of this study (March 1988), we were able to census the herd using the stratified random quadrat sampling method (Gasaway et al. 1986). Because the accuracy and precision of the March 1988

survey far exceeded that of the total counts, the March 1988 results are used exclusively in our demographic analysis.

The stratified random quadrat technique entails three phases: delineation, stratification, and census. The delineation phase involves a fixed-wing survey to establish a survey area that includes the herd's entire late winter distribution. This survey was also supported by a radio-tracking flight to confirm the presence of all radio-collared caribou within the survey area. The delineation survey is extended well beyond the resulting survey area to insure that no detached distribution is missed during the census phase. The stratification phase is an intensive fixed-wing survey over the entire survey area to classify survey units (SU), of 20 km^2 average size, into primary (numerous caribou present) and secondary (few caribou present) strata. The classification of SU's was based on the abundance of fresh snow-tracking sign and the direct observation of caribou.

The census phase involves an intensive and thorough (2 $min./km^2$) helicopter survey of caribou in all the primary SU's and a sample of randomly selected SU's in the secondary stratum. Survey units were systematically surveyed from east to west across the herd's distribution. Two aircraft were used simultaneously for both the stratification and census surveys to reduce the possibility of double counting caribou that could have moved across SU boundaries between survey flights. A subsample of SU's was intensively searched at 6min/km^2 for the purpose of generating a sightability correction factor for caribou missed during the 2$min./km^2$ survey. All data were plotted on topographic 1:50,000 maps. The formulae and HP-97 program developed by Gasaway et al. (1986) were used to calculate the population size of the LRH.

Population Composition

We estimated population composition using two methods during three life cycle periods. The first entailed a helicopter survey of the LRH range, as depicted by radio-collars, during post-calving (on 21 and 19 July, 1985 and 1986, respectively), and rut (on 5 and 10 October, 1985 and 1986, respectively). These surveys served multiple purposes in that they provided additional and more specific information on herd distribution and population size.

The second consisted of calculations made from composition data collected during the March 1988 population estimate, using the formula developed by Gasaway et al. (1986). In this case adult female, calf and adult male proportions were weighted to population size, to provide an unbiased estimate of herd structure. The data provided by the March 1988 count are more reliable than post-calving and rut counts because the areas searched are randomly selected, and a large portion (50%) of the herd was observed. The March 1988 count is our best estimate of composition and recruitment because 10 months of mortality have taken place since calving. It is therefore representative of the herd's pre-calving structure, and thus should be used as the principal composition data for demographic analysis.

Adult Natural Mortality

The natural mortality rate of adult caribou excludes human caused mortality and was estimated by tracking the death rate of radio-collared females. The natural mortality rate was calculated using the formula derived by Gasaway et al. (1983).

Harvest

The LRH is hunted in both Yukon and British Columbia. Since 1979 the Yukon big game harvest has been estimated by the hunter questionnaire survey, which annually samples 70% of licensed resident hunters (Smith and Hare 1988). Unfortunately, there is no statement of the accuracy/precision of this survey. Guided non-resident hunters must report their harvest of big game by trophy export declarations. Non-native harvest is restricted to males only from 1 August to 31 October. The harvest by native subsistence hunters is not well documented in Yukon because legislation enables Indian people to hunt for food without a license. Hence many native subsistence hunters are not sampled by the hunter questionnaire survey. Since native hunters are permitted by Yukon law to hunt any big game species, during any season, without limitation to the amount taken, their harvest may have a substantial impact on some populations. To document this harvest the Yukon Indian Harvest Survey was begun in 1987 (Quock and Jingfors 1988). During that year the harvest of caribou by the Liard Indian Band was surveyed and provides one year of LRH harvesting data by natives. The Liard Band area includes the LRH distribution in Yukon. The remainder of LRH home range includes the Kaska Dene Council and Good Hope Lake Indian Band areas in B.C.

Since 1978 the LRH harvest in British Columbia has been tallied by compulsory inspection for both resident and non-resident hunters (file data, B.C.F.& W Br., Smithers). There is some unreported native subsistence harvest in British Columbia, but the magnitude of this harvest is unknown (D. Steventon pers. comm.). The non-native harvest in British Columbia is restricted to trophy males only from 1 September to 10 October. Trophy males are males with one antler bearing at least 5 points above the rear point.

HABITAT USE

Food Habits

The winter food habits of the LRH were examined by composite fecal sample collections made during February and March between 1985 and 1988. Each year sampling sites were chosen at various locations on the herd's winter range. Each composite sample contained 20 fecal pellets, one from each of 20 different fecal pellet groups. Fecal samples were analyzed at the Composition Analysis Laboratory at Colorado State University in Ft. Collins, Colorado. The relative density of plant fragments was based on 100 fields per sample. The microhistological analysis of caribou samples was tabled, indicating the percentage of each plant group. The

accuracy of fecal analysis is influenced by differing digestion rates among the major food groups (Holechek et al. 1982), and is an estimate of the composition of the winter diet, rather than actual proportions ingested. The rumen turnover rate for caribou is about two days (White and Trudell 1980). Therefore, fecal collections should be representative of food intake for 20 caribou over a much broader area than the actual collection sites. Fecal analysis provides a crude assessment of LRH winter range condition.

Winter Severity

Snow conditions during winter have a profound effect on caribou ecology (Russell and Martell 1984). The amount, annual variability, and distribution of snow on the winter range are important components dictating winter severity. To assess snow conditions encountered by LRH caribou over the duration of this study, we measured snow depth in three ways.

First, to examine the amount of snow for a given year on the Yukon portion of the winter range, we selected 8 sites recently occupied by caribou, as indicated by tracking sign between 20 and 24 February, 1985. Second, to measure between year variability of snow depth, we established 8 permanent stations located along highways relative to the LRH winter range. These stations were sampled from 1985 to 1987. Third, to test for the presence of a snow depth gradient from the Cassiar Mountain area in the south to the Liard Basin in the north we measured snow depth at 8 stations spaced 13 km. apart along the Little Rancheria River on April 22, 1988. The Little Rancheria River forms a rough north-south transect across the LRH winter range.

Snow depth data relative to the study area was also available from the Water Resource Division of the Department of Indian and Northern Affairs for the Watson Lake airport station (D.I.A.N.D. 1989). Data from this station span 23 years, and thus provide measures of long term winter severity. In all cases snow depth was measured as the mean of 10 samples taken at each station.

RESULTS AND DISCUSSION

SEASONAL MOVEMENTS AND DISTRIBUTION

Radio-collaring

All caribou captured for this study were female, 3 immature and 8 adult (Table 1). Five caribou were captured in Yukon, north of the Alaska Highway during February 1985, to test assumptions that caribou from this area are in fact part of the Little Rancheria herd of British Columbia (Fig. 2). A single caribou (V-05) was captured on the summer range in July 1985. To increase the sample size of radio-collared caribou 5 additional animals were captured on both Yukon and British Columbia portions of the LRH winter range in February 1986.

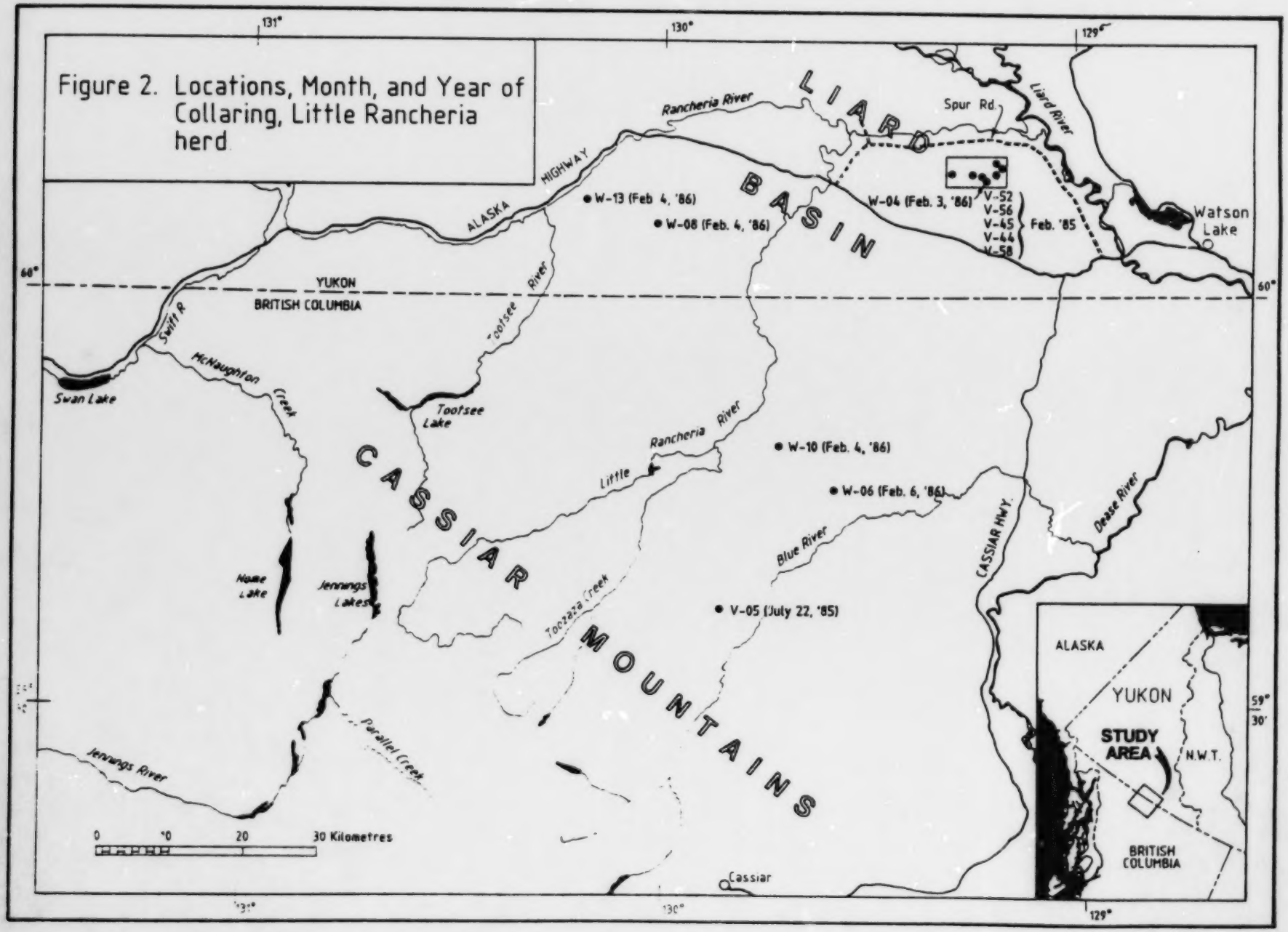


Figure 2. Locations, Month, and Year of Collaring, Little Rancheria herd
131°
130°
129°
60°
59° 30'
LIARD
BASIN
CASSIAR
MOUNTAINS
Rancheria River
Liard River
Spur Rd.
ALASKA HIGHWAY
W-13 (Feb 4, '86)
W-08 (Feb. 4, '86)
W-04 (Feb. 3, '86)
V-52
V-56
V-45
V-44
V-58
Feb. '85
Watson Lake
YUKON
BRITISH COLUMBIA
Swift R
Tootsee River
McNaughton Creek
Swan Lake
Tootsee Lake
Rancheria River
Little
W-10 (Feb. 4, '86)
W-06 (Feb. 6, '86)
Dease River
CASSIAR HWY.
Blue River
Home Lake
Jennings Lakes
Toccaza Creek
V-05 (July 22, '85)
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA

Table 1. Radio-collaring data for the Little Rancheria caribou herd.

Date	Collar	Sex	Age	Location	End Status	No. of Relocations
85/02/21	V-52	F	Adult	Liard Basin	Alive	9
85/02/22	V-56	F	Adult	Liard Basin	Dead	4
85/02/23	V-45	F	Adult	Liard Basin	Dead	1
85/02/23	V-44	F	Immature	Liard Basin	Dead	5
85/02/24	V-58	F	Immature	Liard Basin	Alive	9
85/07/22	V-05	F	Adult	Blue River	Alive	6
86/02/03	W-04	F	Adult	Liard Basin	Alive	4
86/02/04	W-10	F	Adult	Captain Lake	Alive	4
86/02/04	W-13	F	Adult	Tootsee River	Alive	5
86/02/04	W-08	F	Immature	Rancheria R.	Alive	5
86/02/06	W-06	F	Adult	Captain Lake	Alive	4

Distribution Surveys

A total of 35 hours of fixed wing time was flown on 9 occasions (Appendix A) to obtain 56 contacts with radio-collared caribou. The data for all relocations are presented in Appendix B. Distribution data from collaring, composition and census flights (76 hrs. helicopter) provided additional information on the distribution of the LRH.

a) Winter Distribution

The LRH winter range lies entirely within the Liard Basin (Fig. 3). This area extends from the Liard River, near Watson Lake, westward to the eastern flank of the Cassiar Mountains, and southeastward across the lower reaches of the Little Rancheria and Blue Rivers to the Cassiar Highway, which approximates the western boundary. The winter range is roughly 4467 km^2 (1725 mi^2) in size, with 49% (2165 km^2 or 846 mi^2) in Yukon and 51% (2282 km^2 or 891 mi^2) in British Columbia. A core wintering area was apparent from surveys, and was inhabited by most caribou during all years of the study. That area formed an arc that encompassed most of the lower Little Rancheria River valley (Fig. 3). Equal numbers of radio-collared caribou were found in each jurisdiction during winter.

The Alaska Highway bisects the Yukon portion of the herd's winter range, and facilitates access to the herd. Native subsistence hunters from Watson Lake and Lower Post are known to hunt LRH caribou from late November, when caribou migrate to winter range, to late April, when caribou migrate to summer range (B. Tokarek, and J. Russell pers. comm.). Therefore, a potential exists for large scale uncontrolled harvests.

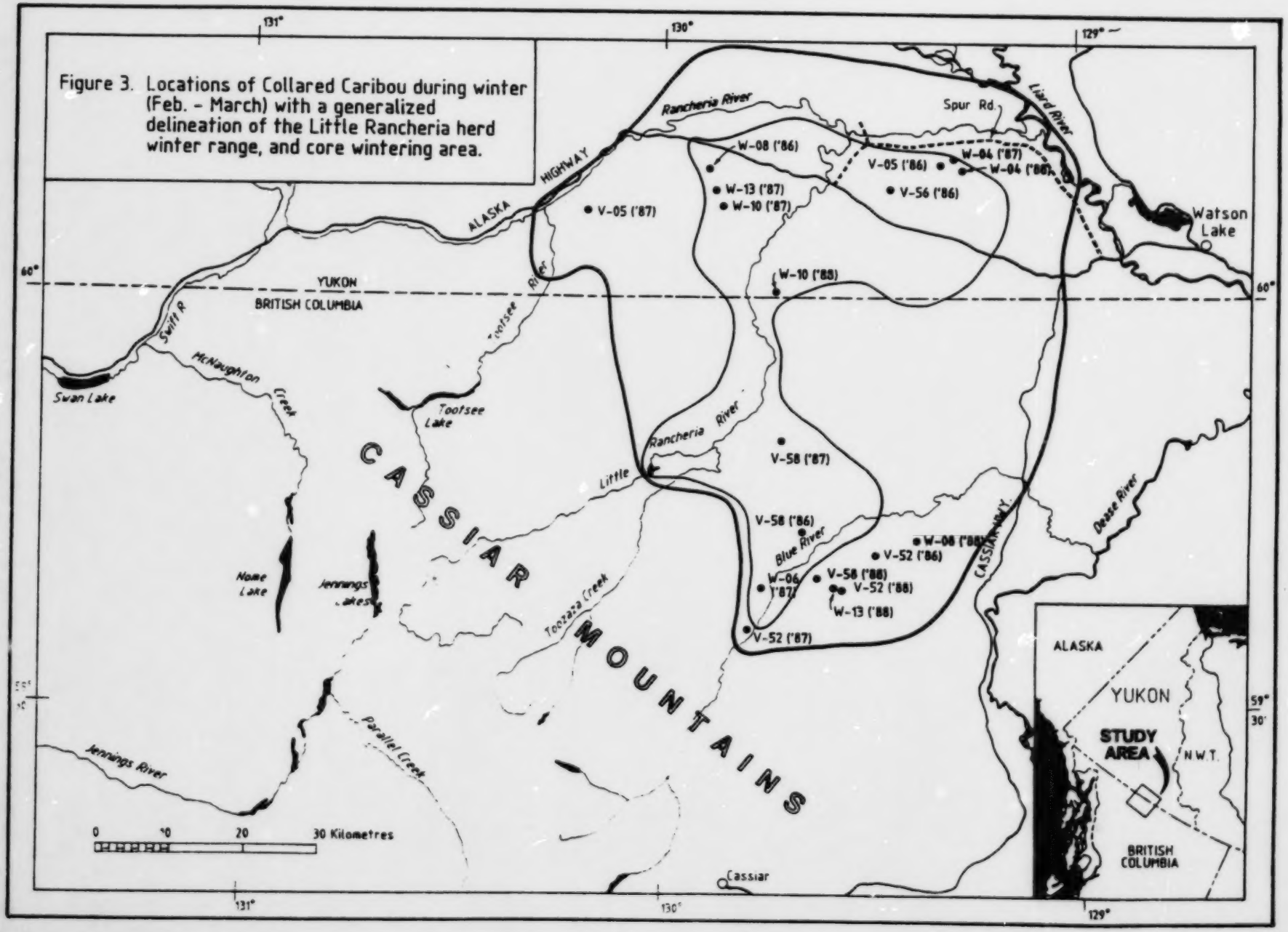


Figure 3. Locations of Collared Caribou during winter (Feb. - March) with a generalized delineation of the Little Rancheria herd winter range, and core wintering area.

The LRH winter range can be roughly categorized into three habitat types in relation to caribou;

1. Old growth white spruce communties along the main river drainages, such as the Liard in the north end of the study area, is the least abundant habitat type, and did not appear to be used by caribou. Caribou were not observed in these habitats during all winters of this study. The reason for this is not entirely clear but could be related to lower lichen abundance and/or higher snow depths in those regions.
2. Lodgepole pine communites are located throughout all the upland sites, and is the most prevalent habitat type on the LRH winter range. Caribou did not appear to utilize this habitat for foraging, as little cratering activity was noted. The activity observed was limited to linear movement through the habitat type, as evidenced by caribou tracks in the snow. In general, the lodgepole pine stands of the Liard Basin are quite unique for Yukon in that they are extremely dense and form a forest canopy that essentially prevents solar radiation from reaching the understory. Hence, ground lichens and other caribou forage is scarce, expalining the lack of caribou activity there.
3. Mixed forest communities dominated by scattered white and black spruce, fall out as the second most abundant habitat type on the LRH winter range. This habitat corresponds to lowland drainges that do not include the main rivers. It is located peripheral to, and essentially surrounding, the upland lodegpole pine habitat. From the air, this habitat appears as a mosaic pattern within the uniform pine stands. When we surveyed the LRH winter range intensively, (to census the herd in March 1988) we noted that caribou were in fact inhabiting the mixed forest habitat type almost exclusively. Thus, the detailed distribution of the herd during winter is quite varied within the boundaries presented on Figure 3.

Timber harvesting should be planned carefully to maintain mixed forest habitats, the apparent preffered habitat of caribou.

b) Calving Distribution

By early June most radio-collared caribou had moved in a southerly direction to calving sites in the northern Cassiar Mountains (Fig. 4). This movement confirmed assumptions that caribou wintering in the Liard Basin (Eccles 1983) are in fact the same herd as counted by Bergerud (1978) in the Cassiar Mountains. The distribution of collared caribou at calving was in mountainous terrain between the headwaters of the Little Rancheria and Blue Rivers, with one exception, that being the location of W-06 in mountains northwest of Tootsee Lake during 1986 (Fig. 4). Given the small sample of collared caribou in this analysis, the behaviour of W-06 at calving could be common. All collared caribou excepting V-58 were located in alpine habitats during calving. V-58 was collared as an immature caribou and likely did not calve in 1985 when it was located in forest habitat.

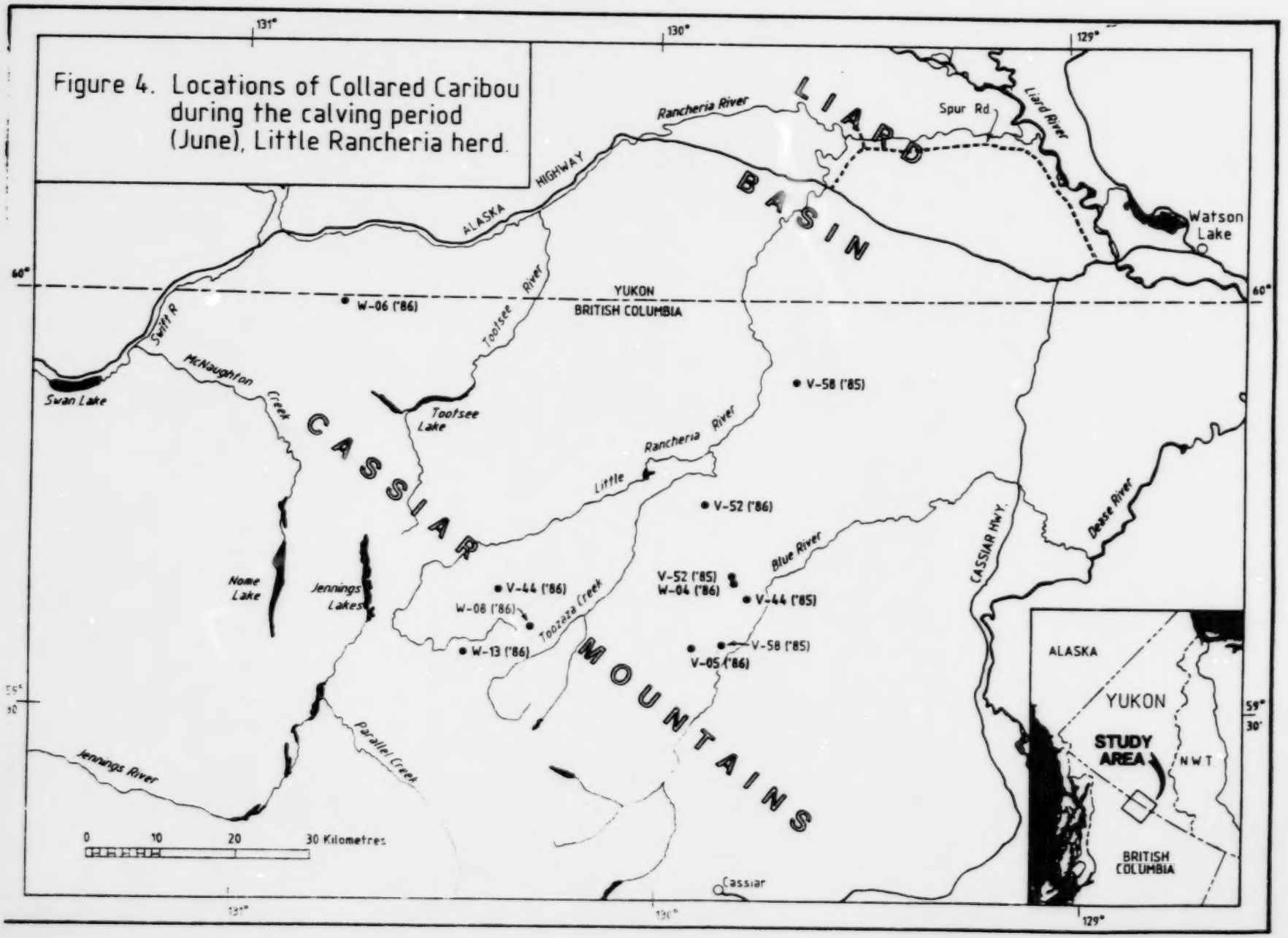


Figure 4. Locations of Collared Caribou during the calving period (June), Little Rancheria herd.
131°
130°
129°
60°
59° 30'
Rancheria River
LIARD
BASIN
Spur Rd
Liard River
ALASKA HIGHWAY
Watson Lake
YUKON
BRITISH COLUMBIA
W-06 ('86)
Swift R
Toolsee River
McNaughton Creek
Swan Lake
Toolsee Lake
CASSIAR
MOUNTAINS
V-58 ('85)
Rancheria River
Little
V-52 ('86)
Blue River
Dease River
CASSIAR HWY.
Nome Lake
Jennings Lakes
V-44 ('86)
W-08 ('86)
Toozaza Creek
V-52 ('85)
W-04 ('86)
V-44 ('85)
W-13 ('86)
V-58 ('85)
V-05 ('86)
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
NWT
BRITISH COLUMBIA

c) Post-calving Distribution

Distribution was more confined during the July post-calving period. Most caribou were found on the alpine plateaus between the Little Rancheria and Blue Rivers (Fig 5). Large band sizes were common, as caribou aggregated into groups numbering upwards to 60 animals. Grouping behavior may have been in response to fly-harassment and/or heat stress because most groups were found on wind-swept ridges or snowpatches (Ion and Kershaw 1989).

d) Fall Distribution

The distribution of collared caribou was most confined during the fall breeding season; all caribou were located in alpine habitats of the Little Rancheria River and Toozaza Creek headwaters (Fig. 6). Caribou were concentrated in large groups distributed in a manner almost identical to that by Bergerud (1978), indicating that this area is a traditional rutting ground for the LRH. It was our impression that while winter counts using the stratified random quadrat method are preferred, significant sample sizes of LRH caribou can nevertheless be efficiently counted on this rutting ground for analysis of herd composition.

e) Home Range Boundaries

Based on radio-collar data, and other reconnaissance surveys, the home range of the LRH is roughly 7356 km2 (2840 mi^2) in size (Fig. 7). The Yukon game management subzones that correspond to this range are 10-29 to 10-32 (Fig. 8) and include most of the wintering area used by the herd. Only game management subzone 10-29 encompasses areas used by the herd during other seasons. In British Columbia the range of the LRH lies entirely within Management Unit 6-24 north of Cassiar, as outlined in Figure 8. Management actions applied to the LRH should be directed tc these areas alone. Actions over a greater area could influence neighboring caribou populations having other demographic and human use characteristics. Other caribou populations bordering the range of the LRH are: in Yukon, the Wolf Lake herd to the northwest (Farnell and McDonald 1989), in British Columbia, the Kawdy-Level herd to the south and the Horseranch herd to the east (Bergerud 1978).

HERD DEMOGRAPHY

Population Size

The LRH census was carried out over a 6 day period between 27 March and 1 April, 1988. The data collected to calculate the population size of the LRH is presented in Appendix C. A survey area of 1099 km^2 was established around two relatively distinct centers of caribou distribution (Fig. 9). The survey area encompassed the entire winter distribution of the herd. This assumption was supported by the presence of all active radio-collar transmitters (Fig. 9) within the survey area, and the absence of any caribou sign well beyond its limits.

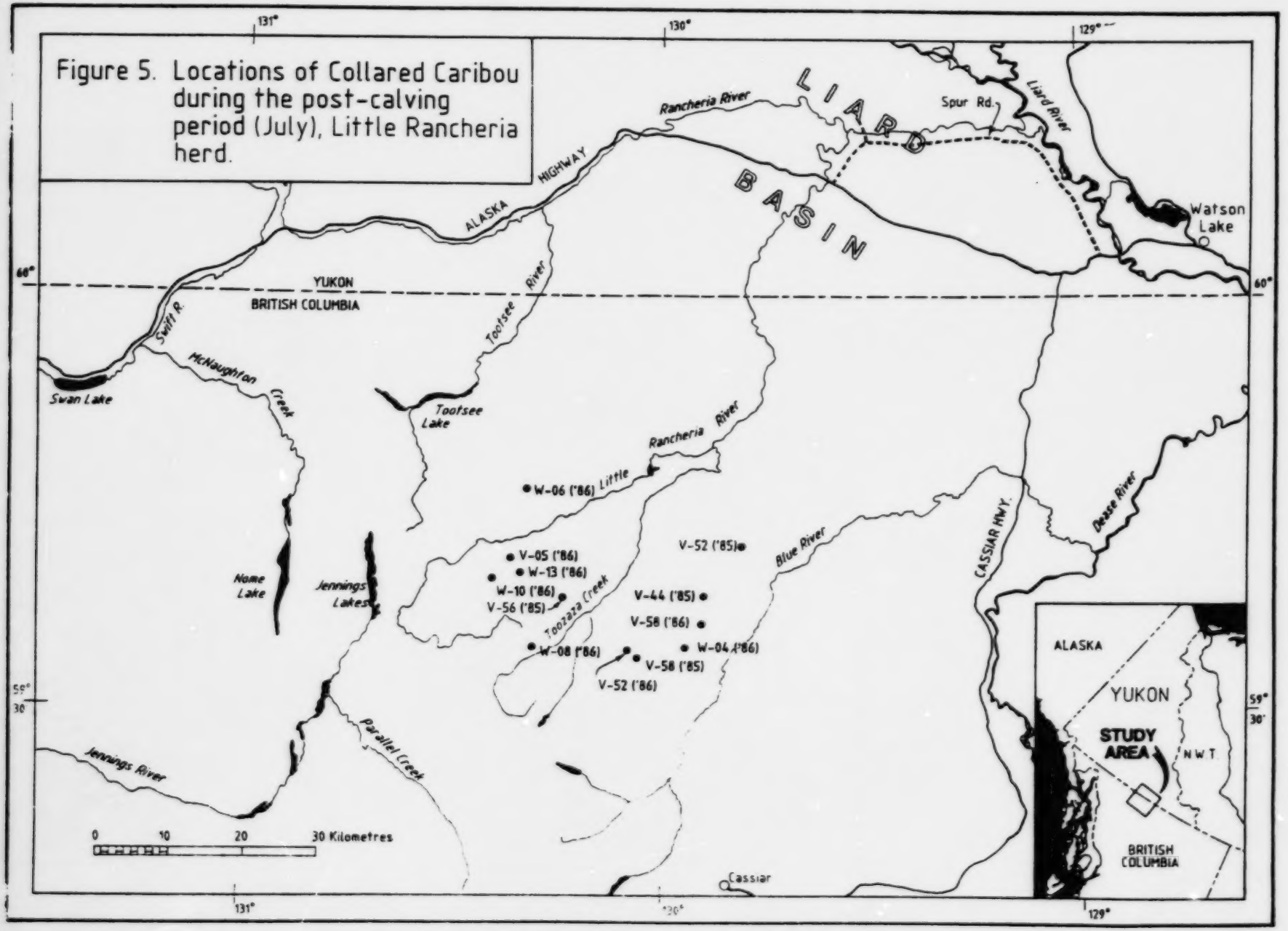


Figure 5. Locations of Collared Caribou during the post-calving period (July), Little Rancheria herd.

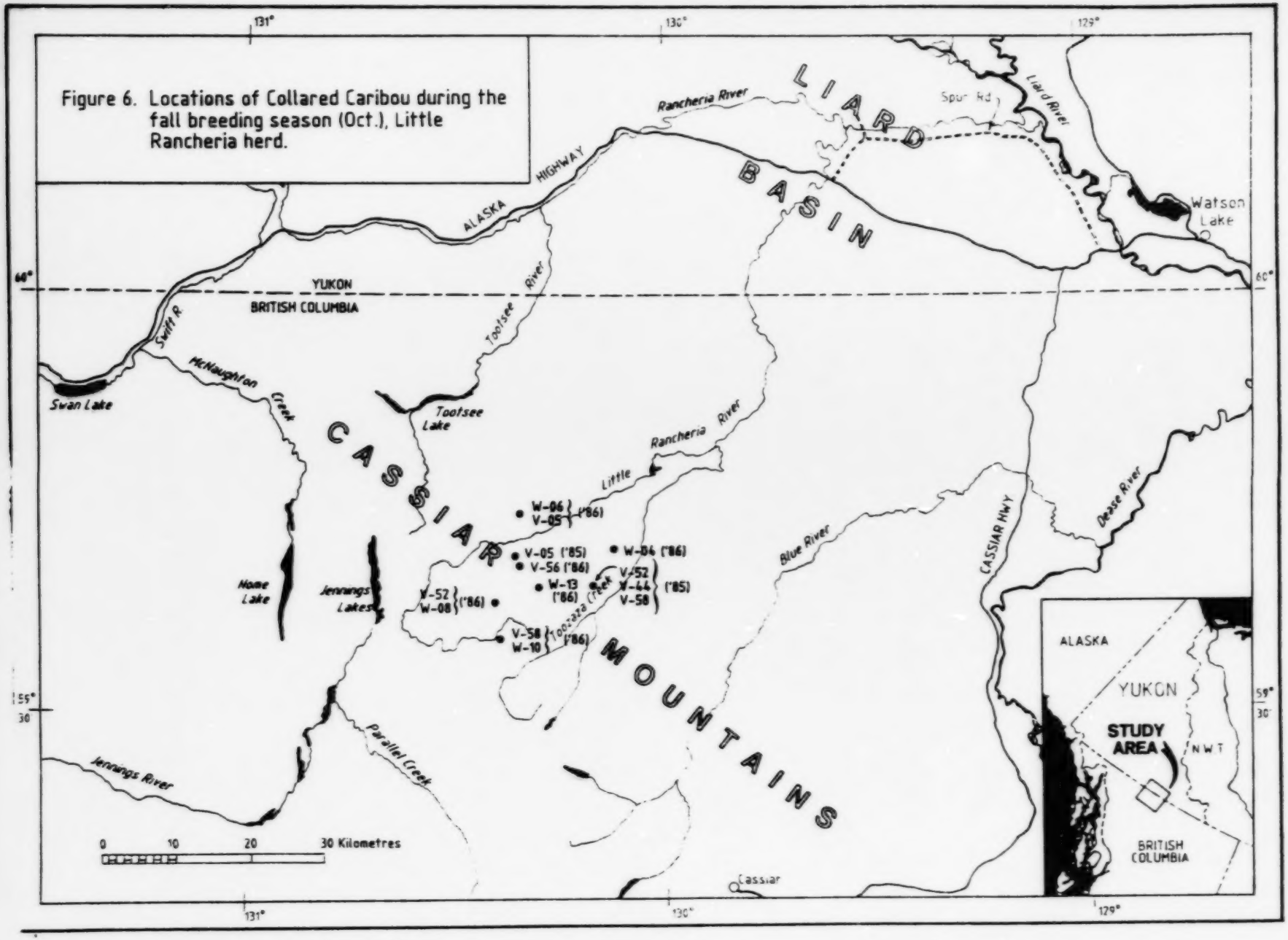


Figure 6. Locations of Collared Caribou during the fall breeding season (Oct.), Little Rancheria herd.

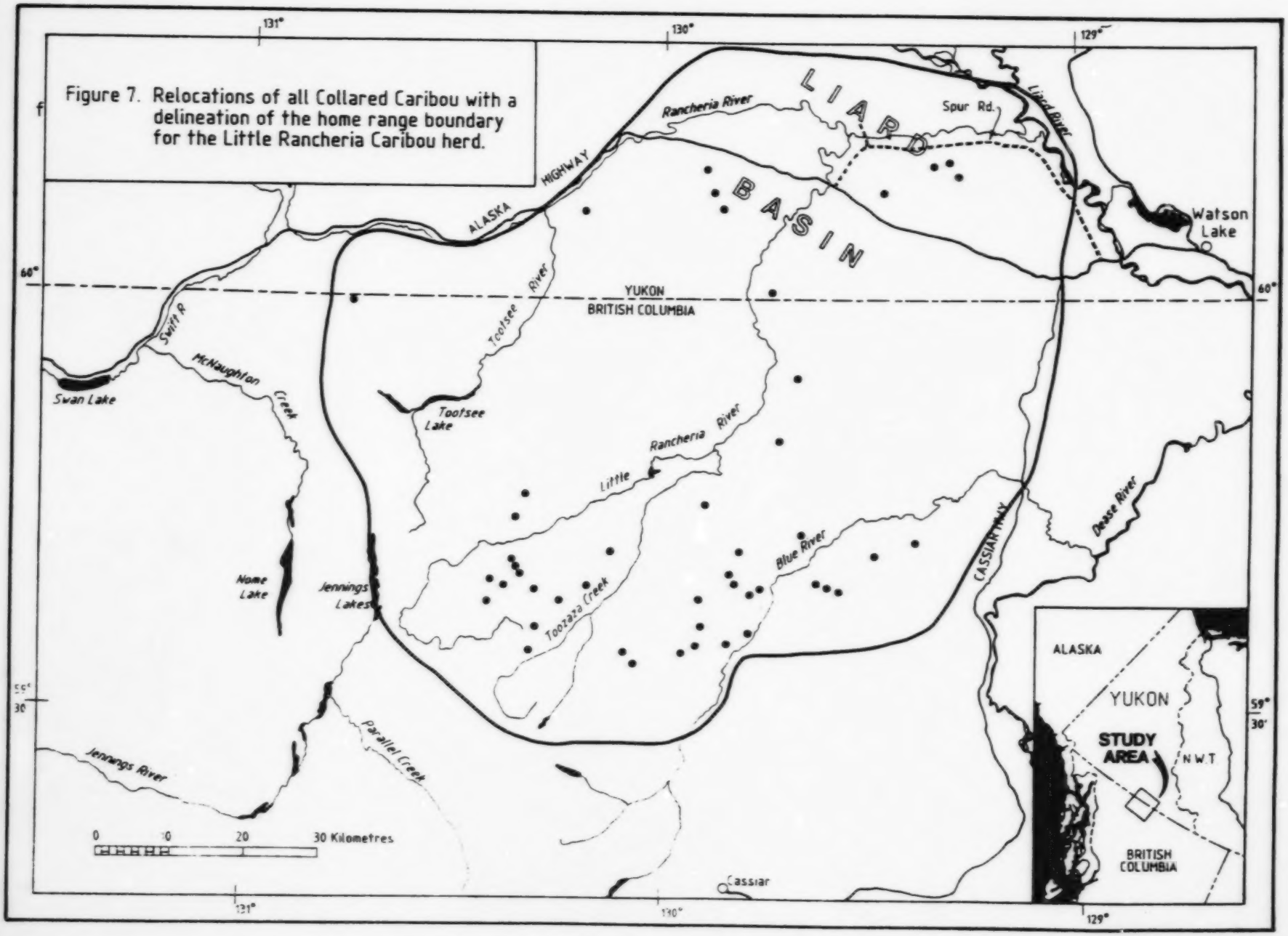


Figure 7. Relocations of all Collared Caribou with a delineation of the home range boundary for the Little Rancheria Caribou herd.

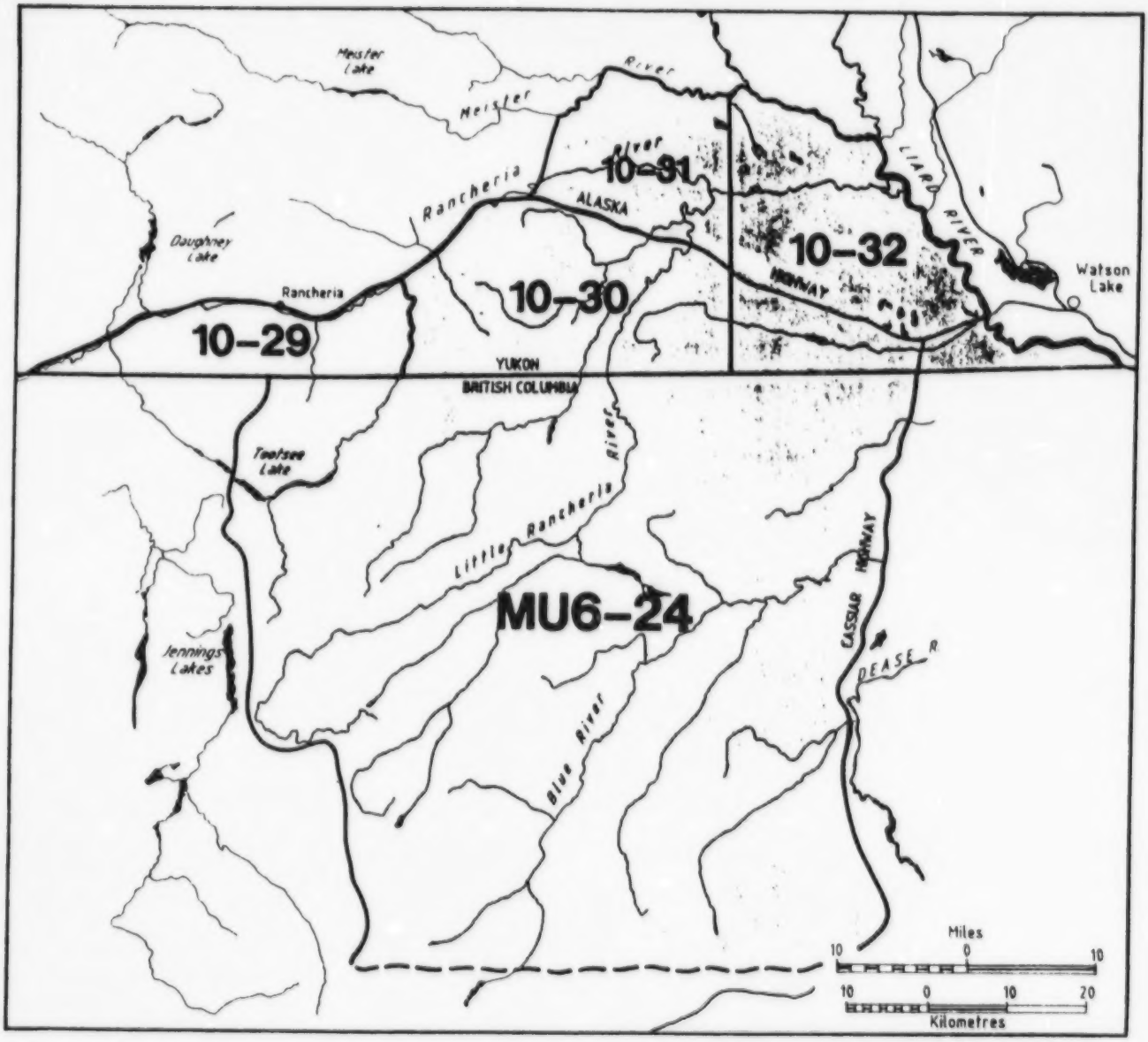


Figure 8. The Yukon game management subzones and British Columbia management unit that correspond to the home range boundary of the Little Rancheria Caribou herd.

The survey area was subdivided into 46 sample units (SU's) averaging 24 km^2 in size. When stratified, there were 8 primary and 38 secondary SU's, comprising 19% and 81% of the total survey area (Table 2). The survey intensity was 54% (25/46) overall with 100% of the primary SU's and 45% (17/38) of the secondary SU's being sampled.

Table 2. Summary of caribou survey data, and population estimate for the Little Rancheria caribou herd at the 90% confidence level, March 1988.

Strata	Sample Units		Area (km^2)		Caribou Observed	Expanded Population Estimate	*Population Estimated With SCF
	Sampled	Total	Sampled	Total			
Primary	8	8	209	209	187	187.5	—
Secondary	17	38	430	890	152	314.6	—
Totals	25	46	639	1099	339	502.0	681

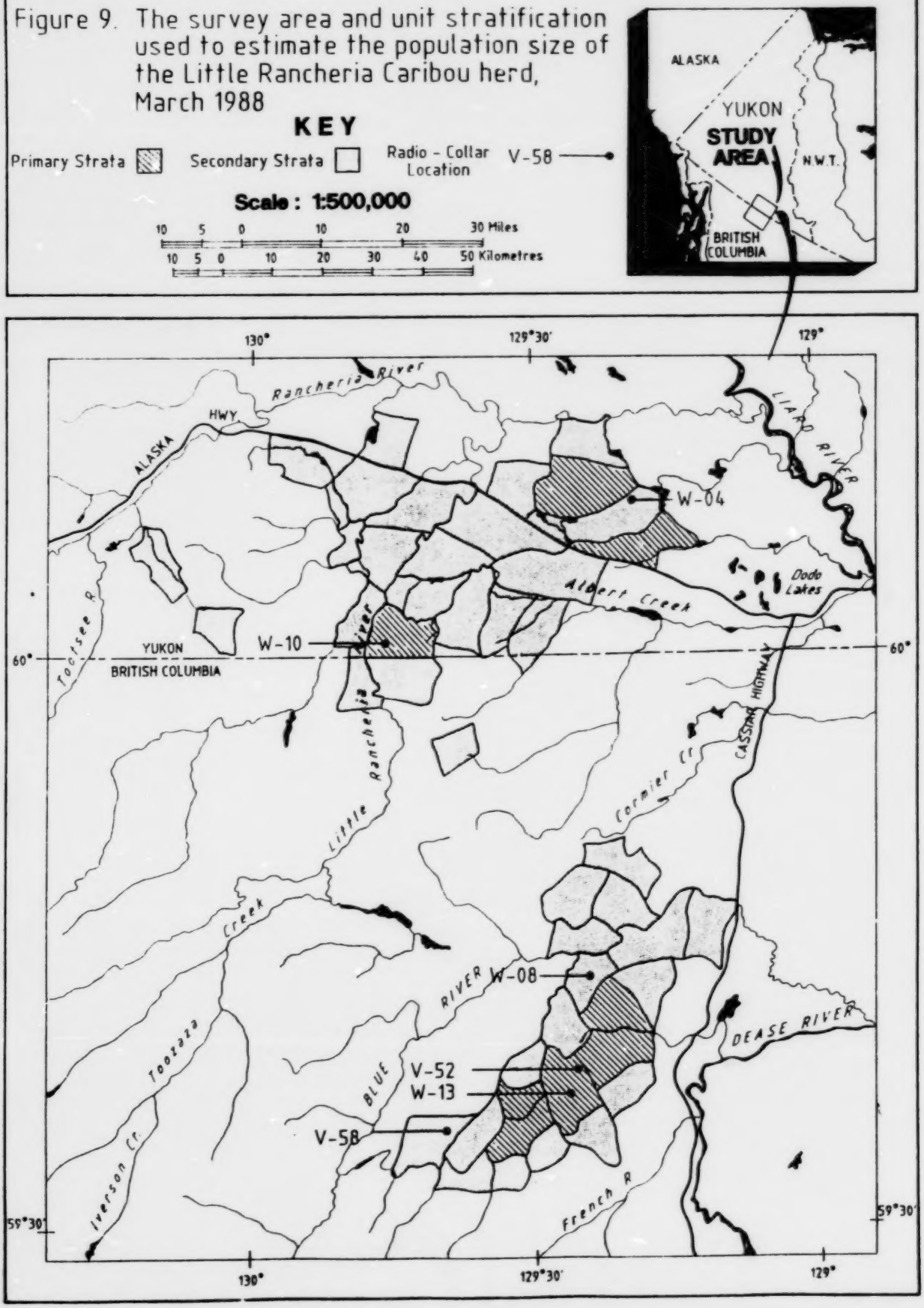
*Population estimate from Gasaway et. al. (1986) with a sightability correction factor of 1.357.

The search intensity averaged 2 min/km^2 during the census flights. There was no appreciable difference in search intensity between strata during the census. A total of six intensive survey areas (avg. size 4 km^2), within primary SU's were selected and flown again at 6 min/km^2 intensity to estimate a sightablility correction factor (SCF) (Appendix C).

A total of 187 caribou were counted in the primary stratum, and 152 in the secondary stratum (Table 2). When using a SCF of 1.357, the estimated population size for the LRH was 681 $\pm$ 20% (545-817) at the 90% confidence level.

The population size estimated by the stratified random quadrat technique during March 1988 far exceeded our best previous count of 373 caribou during October 1986 (Appendix D). Large disparities between fall total counts and winter population estimates have been observed for other Yukon herds, and can be attributed to greater efficiency for the stratified random quadrat method during winter (Farnell and Gauthier 1988). The population size reported by Bergerud (1978) was derived by the total count method during fall and does not provide a reliable comparison with our estimate because there is no statement of that count's accuracy/precision, or a correction for animals not seen on the survey. We are therefore unable to calculate a rate of change in LRH numbers.

Figure 9. The survey area and unit stratification used to estimate the population size of the Little Rancheria Caribou herd, March 1988



Population Composition

Because of their greater reliability we have restricted our composition analysis to the March 1988 (Table 3) and October 1985 and 1986 (Appendix D) data sets. The data provided by the July 1985 and 1986 counts (Appendix D) are subject to large bias because they represent composition proportions during a period when the herd is socially segregated by sex and age. They are provided for reference purposes only. The fall counts have less bias because they reflect proportions when the herd is homogeneously mixed by sex and age, but are derived only from that portion of the herd located in alpine area during the breeding season. The March counts are least biased because they are based on a random selection, derived from a large sample size, and are weighted to population size. Because of its greater reliability the March count should be used for demographic analysis. The fall counts are useful to compare estimates for an evaluation of consistency.

Adult females made up 62.7% and males 18.7% of the estimated population in March 1988. These proportions compare well with those found during the fall surveys in 1985 and 1986, which were 59% and 63% respectively for females and 18% and 20% for males. The corresponding sex ratio for the herd is heavily skewed toward females (29.7 males/100 females, March 1988), and this conclusion is supporteed by findings during fall counts 1985 and 1986 (30 and 32 males/100 females respectively). The sex ratio of the LRH is similar to that found for neighboring caribou herds and is thought to be the product of differential predation rates, not harvesting patterns. Refer to Farnell and McDonald (1989) for a detailed discussion on woodland caribou sex ratios in northwestern B.C. and southeastern Yukon.

Calves made up 18.6% of the total population in March 1988, and compare closely to fall proportions which were 17% in 1985 and 20% in 1986. When calculated as a ratio (29.8 calves/100 females, March 1988) calf recruitment indicates a modest level of survival to 10 months of age.

Because proportions compare within 0-5% of each other between the March 1988 and fall 1985-1986 counts, it is our contention that herd composition has not altered a great deal over the course of this study. We therefore believe that these sex ratio and calf recruitment levels are stable and represent the long-term average for the herd.

Table 3. The unbiased composition of the Little Rancheria caribou herd calculated from the March 1988 population estimate at the 90% confidence level.

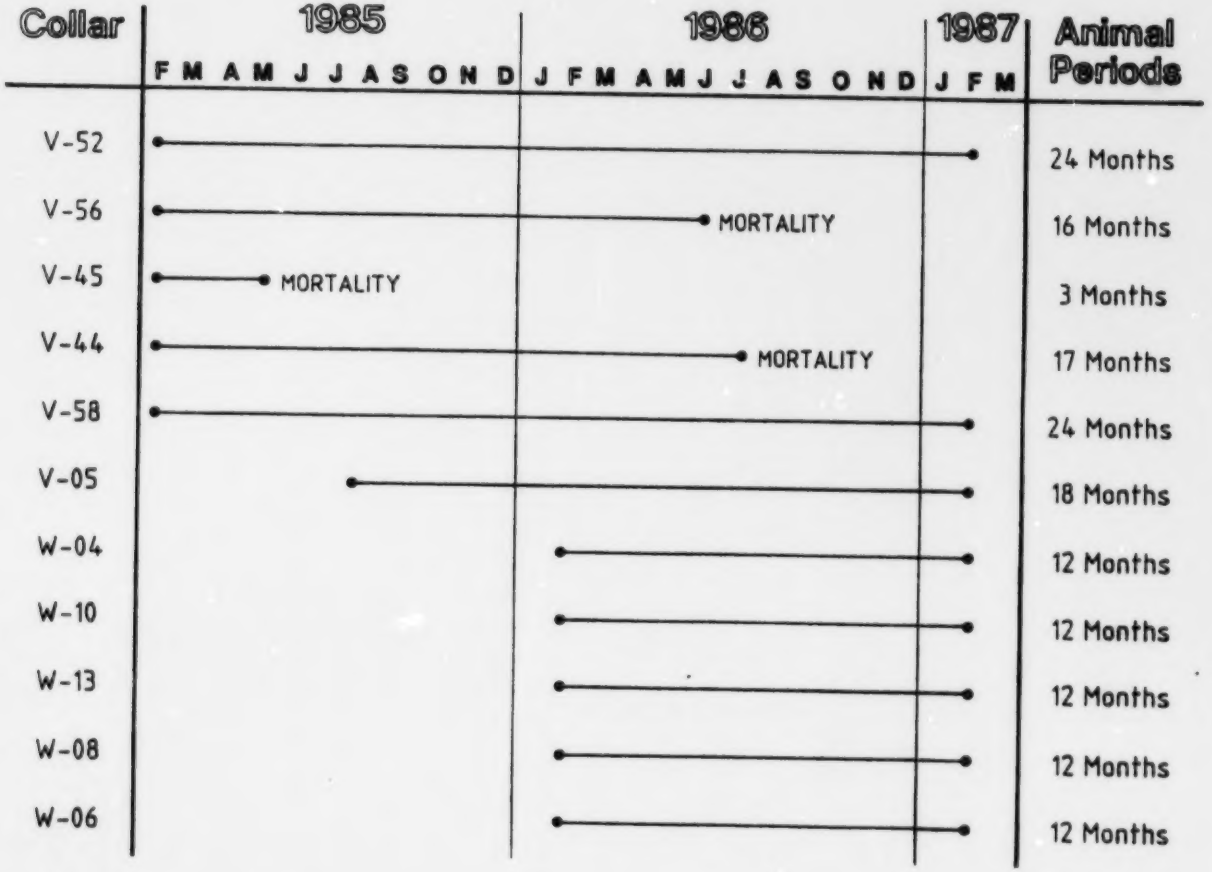
	Adult Females (22 mo.)	Calves (10 mo.)	Adult Males (22 mo.)
Corrected no. of caribou	410 ± 24%	122 ± 30.4%	122 ± 38.2%
Percentage of population*	62.7	18.6	18.7
Ratio per 100 females	____	29.8 ± 18.6%	29.7 ± 26.7%

* 4.0% were unclassified.

Adult Natural Mortality

Three collared caribou died over the duration of this study (Fig. 10); V-45 was found dead as a result of wolf predation in May 1985, V-56 by unknown causes in June 1986, and V-44 as a result of bear predation in October 1986 (Appendix B). Adult natural mortality over the study period was extremely high, and was calculated at 20.8%. We suspect the accuracy of this estimate, however, since radio-collar mortality data derived from small sample sizes leave a great possibility of error. A single change in numbers could alter the rate substantially. For example if V-44 had survived the study (Fig.10), an adult natural mortality rate of 12.9% would have resulted, almost one-half that observed. Further, the calculated rate is an underestimate because it is representative of females, and males are known to have higher natural mortality as evidenced by their lower proportions. The data, if corrected for assumed adult male mortality, would indicate a disastrous population decline, even in the absence of hunting. The observed death rate of radio-collared caribou cannot be representative of the natural mortality rate or the herd would have disappeared. We, therefore, regard this mortality rate as too crude for management purposes. For the future, a reliable estimate of adult natural mortality can be obtained by census extrapolation between our March 1988 population estimate and subsequent census.

Figure 10. Status of individual radio-collared caribou over the duration of the study (February 1985 - February 1987) with animal periods used to calculate the mortality rate, Little Rancheria Caribou herd.



Harvest

The Yukon non-native harvest of LRH caribou is very light and since 1979, has averaged one caribou per year from GMS 10-29 (Smith and Hare 1988), the only portion of LRH summer range in Yukon (Fig. 8). The harvest by native hunters in 1987 was reported to be 5 caribou taken during winter from GMS 10-30 and 10-32 (Quock and Jingfors 1988). Quock and Jingfors (1988) concluded that their survey underestimated the native harvest because some hunters were not reporting their results accurately. We speculated this harvest to be about 10 LRH caribou per year (B. Tokarek and D. Lutz pers. comm.), and an exceptional harvest of 30 caribou during late winter 1988 was recently documented (J. Russell pers. comm.). Native harvest could increase due to recent construction of the Rancheria Spur road (Fig. 1), which encircles much of the herd's Yukon winter range.

For M.U. 6-24 north of Cassiar, (B.C. home range area) the harvest by non-native hunters has ranged from 2 to 17 caribou and has averaged 9 since 1978 when compulsory inspection became mandatory (Table 4). Because most of the LRH summer range is inaccessible, many hunters take caribou by fly-in hunting. Some unreported native harvest is known to take place in B.C. by hunters from lower Post and Good Hope Lake (R. Quock pers. comm.), but the magnitude of this harvest is unknown (D. Steventon pers. comm.).

Table 4. The reported harvest of caribou in British Columbia from the Little Rancheria caribou herd, 1978 to 1986.

Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	$\bar{X}$ & SD
Resident	2	3	3	7	12	5	4	9	5	5.6 $\pm$ 3.2
Non-resident	-	-	5	-	5	4	8	4	5	3.4 $\pm$ 2.8
Totals	2	3	8	7	17	9	12	13	10	9.0 $\pm$ 4.7

Assuming that Yukon native hunters are taking an average of 10 LRH caribou per year, then the annual combined harvest is averaging a minimum of 20 caribou annually or roughly 3% of the herd. Efforts are presently underway to better document the Yukon Indian Harvest Survey and refine this analysis (pers. comm. R. Quock).

HABITAT USE

Food Habits

The percent of discerned plant fragments found in all fecal samples collected on the winter range of the LRH are summarized in Table 5. For reference purposes the percentages found in each sample collected are presented in Appendix E.

The plant composition of fecal samples from the LRH winter range was predominantly lichen (75.5%), which is typical for other woodland caribou herds in Yukon (Farnell and McDonald 1987, 1989) and most caribou populations inhabiting forest environments (Russell and Martell 1984). About 74% of this component was made up of terrestrial lichen (Cetraria and Cladonia spp.) while arboreal lichens (Alectoria and Usnea spp.) represented less than 1% of discernable plant fragments. This finding supports Bergerud's (1978) conclusion that the caribou of northern B.C., which includes the LRH, are of the 'ground lichen' ecotype or boreal forest herds as opposed to the distinct 'arboreal lichen' ecotype or tundra-subalpine herds in the southeastern part of that province. Our on-going food habit investigations are confirming the similar result that all caribou throughout Yukon, woodland and barren-ground combined, are of the 'ground lichen' ecotype.

Lichen was followed by evergreen shrubs as the second most common component (13%). We now believe that the presence of Pinus (7%), the most abundant evergreen in fecal samples, is due to incidental ingestion from foraging on terrestrial lichen. We draw this conclusion largely because this species constitutes a large portion of forest floor detritus in the Liard Basin and is inevitably consumed by caribou seeking out ground based vegetation. We no longer hold our previous view that foraging on arboreal lichen leads to incidental consumption of Pinus, as was concluded for similar results in the neighboring Wolf Lake herd (Farnell and McDonald 1989). If that activity was the source of observed amounts of Pinus the incidence of arboreal lichen in fecal samples should be larger.

The third most abundant component in fecal samples was grasses and sedges (6%), which provide a protein source for caribou during winter and enhance the nutritional quality of LRH diet. This factor coupled with the low incidence of moss (1.6%) indicate that adequate forage is available for caribou. A high incidence of moss is considered indicative of poor range condition (D. Russell pers. comm.). It is therefore our distinct impression from these results that the LRH is not grossly limited by the availability of winter forage.

Table 5. Average percent relative frequency of discerned plant fragments from fecal samples collected during winter on the range of the Little Rancheria caribou herd from 1985 to 1988.

Plant Genus or Group (sample frequency)	Average Percentages (± SE)	
Moss(5/7)		1.6 (0.75)
Fruticose Lichens(7/7)		74.0 (5.32)
(Terrestrial)		
Cetraria-type(7/7)	3.8 (0.45)	
Cladonia-type(7/7)	69.9 (5.43)	
(Arboreal)		
Alectoria(1/7)	0.3 (0.25)	
Usnea(1/7)	0.1 (0.14)	
Foliose Lichens(4/7) (Peltigera)		1.5 (0.92)
Horsetails(6/7) (Equisetum)		3.6 (1.38)
Graminoids(7/7)		6.0 (3.83)
Carex(6/7)	5.4 (3.99)	
Festuca(3/7)	0.4 (0.32)	
Unknown Grass(1/7)	0.1 (0.14)	
Unknown Sedge(1/7)	0.1 (0.23)	
Evergreen Shrubs(7/7)		12.9 (3.29)
Ledum(6/7)	4.3 (2.29)	
Picea(5/7)	1.0 (0.54)	
Vaccinium(2/7)	0.1 (0.13)	
Cassiope(1/7)	0.07 (0.19)	
Pinus(7/7)	7.3 (1.97)	
Empetrum(2/7)	0.1 (0.18)	
Unknown Ericaceae(1/7)	0.04 (0.10)	
Forbs(5/7)		0.5 (0.22)
Lupinus(5/7)	0.5 (0.22)	
Astragalus(1/7)	0.09 (0.24)	
Total Lichens(7/7)		75.5 (0.52)

Snow Distribution

The mean depth of snow at the Yukon winter range stations (79 cm.) was not favorable for caribou during late February 1985 (Table 6, Fig. 11) because it was in excess of what is critical for solitary animals to dig craters (50-60 cm.), and close to levels critical for cratering by groups of caribou (80-90 cm.). These thresholds are known to restrict the mobility of caribou (Russell and Martell 1984). Snow depths during winter 1985 were above average however, as the depth measured at Watson Lake airport for 1985 (74 cm.) was 25% higher than the 23 year average for that station (59 cm.). The 1985 data is therefore not representative of the 'normal' snow conditions on the LRH winter range. The values for the Yukon winter range stations and Watson Lake airport were strikingly close in 1985, suggesting that the Watson Lake airport snow station may be representative of snow conditions encountered by LRH caribou. This assumption should be verified by more comprehensive snow sampling in both B.C. and Yukon portions of the LRH winter range for comparison.

When compared to the long term mean at Watson Lake airport (59 cm.), the snow data collected during this study from our permanent stations (Table 6, Fig. 11), and at Watson Lake airport, indicate a pronounced similarity in trend. Thus 1985 was an above average year for snow depth, mean of the permanent stations was 92 cm. vs. 74 cm. at the Watson Lake Airport, 1986 was below average, mean of the permanent stations was 56 cm. vs. 36 cm. at the Watson Lake airport, and 1987 was an average year, mean of the permanent stations was 61 cm. vs. 59 cm. at the Watson Lake airport.

If for the present, we cautiously assume that snow measurements taken at Watson Lake airport are representative of conditions on the winter range, some conclusions can be drawn regarding long term severity of winters. Thus, caribou have encountered snow depths ranging anywhere from the 36 cm. observed in 1986 to 89 cm. observed in 1976 (Table 6). Given that snow depths greater than 80 cm. restrict movements of groups of caribou, their have been only 2 years of highly unfavorable conditions, 1967 (87 cm.) and 1976 (89 cm.), and 8 years of favorable snow conditions in the record, given that depths less than 50 cm. do not significantly restrict caribou movements. Overall, snow depths as measured at Watson Lake airport indicate that most years are critical, however, because 15 of the 23 years had depths equal to or exceeding 50 cm.

A snow depth gradient was apparent from the 1988 sampling (Table 6, Fig. 11). This pattern was not characterized by a uniform decrease in snow depth from the Cassiar Mountains in the south to the Liard Basin in the north, as expected, but did indicate a decrease in snow accumulation at stations C22 and C23, in the middle of our transect. Thus the gradient dipped as we sampled away from the Cassiar Mountains in the south, and began increasing further north in the Liard Basin. The distribution of caribou along the transect is pertinent to this finding because it corresponded exactly with those sampling sites with the lowest

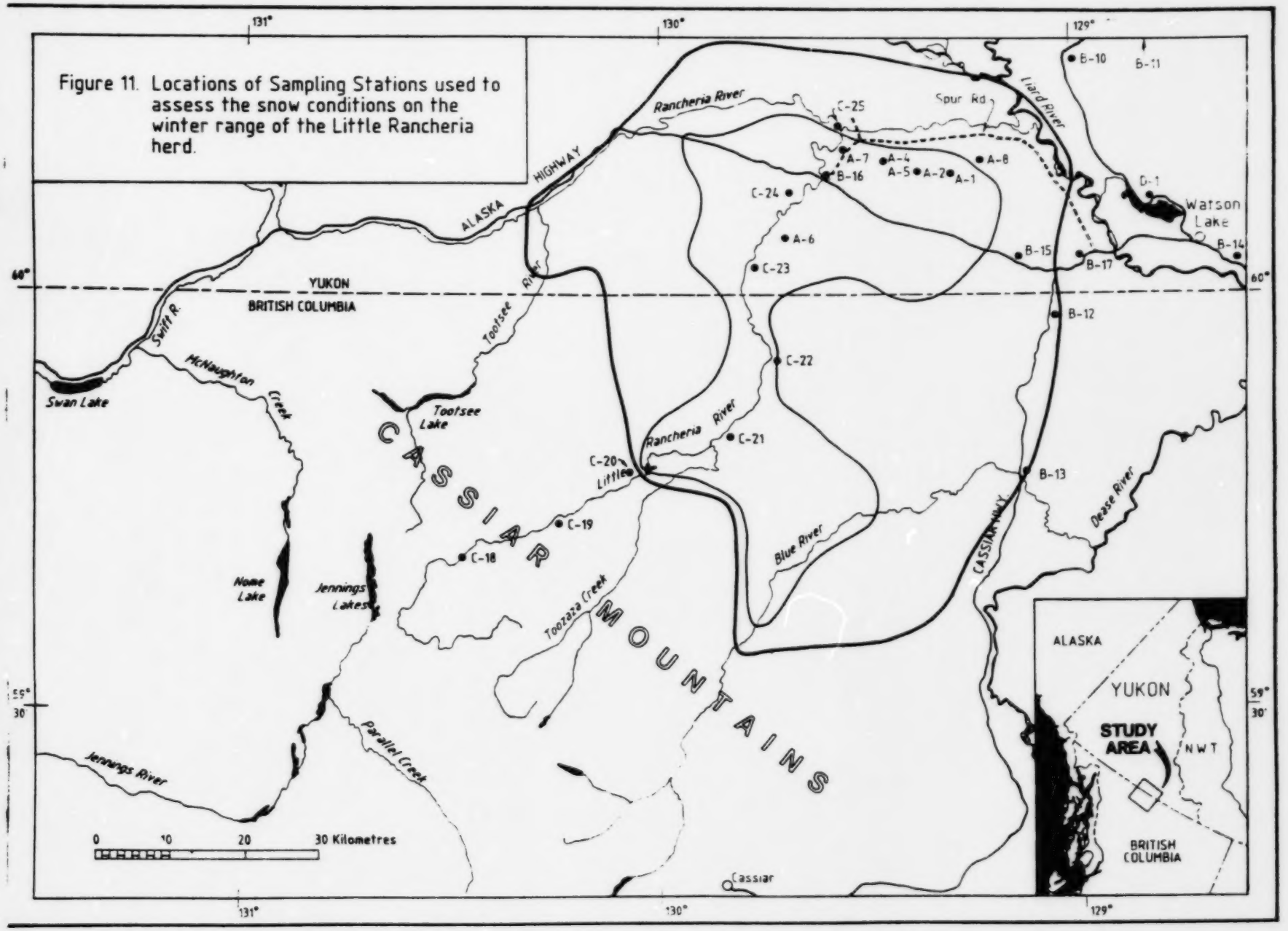


Figure 11. Locations of Sampling Stations used to assess the snow conditions on the winter range of the Little Rancheria herd.

snow depths. The mean snow depth for stations within the caribou distribution (C21 to C23 during the survey) was 49 cm. or 13 cm. less than the overall mean for the transect. This finding in our opinion indicates that caribou were inhabiting the specific area of least snow.

Bergerud (1978) stated that the location of caribou winter ranges can be predicted: "since the prevailing winds laden with moisture in northern British Columbia are from the south and west, snow depths are frequently 2 feet deeper on the west and south sides of mountains than the north and east slopes." The juxtaposition of the LRH winter range to its summer range follows Bergerud's (1978) prediction exactly (Fig's. 3-7). Bergerud's (1978) theory is further supported by the snow characteristics found on other woodland caribou ranges in B.C. (Hatler 1983) and Yukon (Farnell and Russell 1984, Farnell and McDonald 1989, & in prep.).

The tendency of caribou to winter in 'snow shadow' regions constitutes strong evidence that woodland caribou wintering strategies reflect not only the distribution of forage in their range but more importantly the quantity of snowpack. Lichens are of little use to caribou if there is no net benefit in cratering for them. The traditional use of specific winter ranges indicate that this behavior is an obligatory response to climatic factors and more than any other attribute attests to the importance of those habitats for the welfare of a herd. Essentially there is no other place for the animals to go. We therefore contend that land use management must recognize the importance of caribou winter range as critical habitat and discourage conflicting developments.

Table 6. Snow depth data collected within and peripheral to the Little Rancheria herd winter range 1985-1988.

Code	Date	Location	Snow Depth (cm.)
Yukon Winter Range Stations[a]			
A1	85/02/20	T-Bone Lake	69
A2	85/02/21	Open Forest	91
A3	85/02/21	Lake Shore Margin	87
A4	85/02/21	Sedge Meadow	71
A5	85/02/23	Open Spruce Forest	88
A6	85/02/23	Lake Shore	87
A7	85/02/24	Open Pine Forest	80
A8	85/02/24	Three Island Lake	62
			$\bar{X}$ = 79 S.E.= 3.79
Permanent Stations[b]			
B10	85/02/25	Campbell Hwy. km.36	93
B11	85/02/25	Campbell Hwy. km.52	96
B12	85/02/25	Cassiar Hwy. km. 728	99
B13	85/02/25	Cassiar Hwy. km. 705	87
B14	85/02/26	Alaska Hwy. km. 1102	103
B15	85/02/25	Alaska Hwy. km. 1050	87
B16	85/02/25	Alaska Hwy. km. 1079	79
			$\bar{X}$ = 92 S.E.= 3.10
B10	86/03/27	Campbell Hwy. km. 36	59
B11	86/03/27	Campbell Hwy. km. 52	48
B12	86/03/27	Cassiar Hwy. km. 728	56
B13	86/03/27	Cassiar Hwy. km. 705	50
B14	86/03/26	Alaska Hwy. km. 1102	74
B17	86/03/27	Alaska Hwy. km. 1038	51
B16	86/03/27	Alaska Hwy. km. 1079	52
			$\bar{X}$ = 56 S.E.= 3.35
B10	87/03/19	Campbell Hwy. km. 36	54
B11	87/03/19	Campbell Hwy. km. 52	59
B12	87/03/19	Cassiar Hwy. km. 728	63
B13	87/03/19	Cassiar Hwy. km. 705	67
B14	87/03/19	Alaska Hwy. km. 1102	74
B17	87/03/19	Alaska Hwy. km. 1038	58
B15	87/03/19	Alaska Hwy. km. 1050	56
B16	87/03/19	Alaska Hwy. km. 1079	58
			$\bar{X}$ = 61 S.E.= 2.33

Code	Date	Location	Snow Depth (cm.)
Gradient Stations[c]			
C18	88/04/02	Station 1 elv. 3700	115
C19	88/04/02	Station 2 elv. 3550	51
C20	88/04/02	Station 3 elv. 3380	50
C21	88/04/02	Station 4 elv. 3100	54
C22	88/04/02	Station 5 elv. 3000	49
C23	88/04/02	Station 6 elv. 2950	43
C24	88/04/02	Station 7 elv. 2700	65
C25	88/04/02	Station 8 elv. 2420	67
			$\bar{X}$ = 62 S.E.= 8.13
Watson Lake Airport[d] (D1)			
	65/03/01		79
	66/03/01		48
	67/03/01		87
	68/03/01		55
	69/03/01		70
	70/03/01		54
	71/03/01		39
	72/03/01		75
	73/03/01		62
	74/03/01		60
	75/03/01		39
	76/03/02		89
	77/03/01		49
	78/03/02		41
	79/02/23		76
	80/03/04		62
	81/03/02		57
	82/03/01		47
	83/03/01		52
	84/02/24		48
	85/03/02		74
	86/03/01		36
	87/03/01		59
			$\bar{X}$ = 59 S.E. = 3.21

a. Stations selected to examine snow conditions encountered by caribou on the Yukon portion of the LRH winter range
b. Established stations to assess annual variability of snow depth within and peripheral to the LRH winter range. Station B17 was not sampled in 1985, and station B15 was not sampled in 1986.
c. Transect stations used to evaluate if a snow gradient exists across the LRH winter range.
d. Data provided by D.I.A.N.D. (1988).

CONCLUSIONS

1. Since the LRH ranges in both Yukon and B.C. there is an obvious need for cooperative management. In particular, safe harvesting levels must be agreed upon and implemented between jurisdictions. This goal cannot be achieved, however, until native harvest is better documented. While efforts are underway to improve the data in Yukon, we are not aware of any effort to measure the native kill in B.C., and we know that native hunters from Lower Post and Good Hope Lake take unreported amounts of caribou from the LRH.

2. The lack of a reliable natural mortality estimate poses a problem for setting safe harvesting levels. Since the allowable harvest is normally calculated empirically from the remainder of recruitment minus natural mortality we are unable to use that method at this time considering the acknowledged deficiencies in our estimate of the later parameter. Alternatively, we have choosen the approach based on demonstrated experience and provided by Bergerud (1979). Case histories have shown that harvests of 5% or greater, including either sex, in natural caribou-predator systems, lead to population declines among North American caribou herds. Harvest of 3% cause populations to remain stable. In the LRH case both sexes are hunted, and predators are relatively undisturbed. Hence, harvest should not exceed 5% of the March 1988 population size, or 34 caribou, and to insure herd stability, should be maintained at 3%, or 20 caribou.

3. A second population estimate of the LRH will improve harvest management. An assessment of the actual growth rate can be made, and if harvest is estimated accurately, an empirical evaluation of the adult natural mortality rate can be derived by census extrapolation. Moreover, since access to the LRH is improving each year due to logging, and the Yukon native harvest is unregulated, the herd is menaced with the potential for excessive kill. For these reasons it is important that a second population count be made within a reasonable time interval for demographic analysis.

4. Old growth white spruce forests along the main river drainages, such as the Liard in the north end of the study area, are presently the only economic source of sawlog material for local manufacture in Yukon (Holmquist and Senger 1988). Because they are not habitats used by caribou, logging of those stands should not have an impact. However the supply of white spruce is limited and hence long-term harvesting plans will include other species. It is therefore reasonable to assume that portions of the extensive lodgepole pine forests, away from the main rivers, will be needed to maintain the industry. In that event, timber harvesting will require careful planning to maintain those ground lichen habitats preferred by caribou (among the mixed forest habitats interspersed and peripheral to the upland lodgepole pine communities).

RECOMMENDATIONS

1. The B.C. government should undertake measures to estimate the native harvest of LRH caribou, or if that is not possible, those communities should be surveyed by the Yukon Native Harvest Study for caribou kill.

2. The governements of B.C. and Yukon should cooperate to insure that the annual LRH harvest does not increase and excceed 20 caribou. This limitation should be imposed until more refined population information is forthcoming.

3. A population estimate should be made 5 years after the first count, in 1993. At that time precise harvest levels can be set.

4. Logging plans must take into account access development, sequence of logging, logging methods, silvicultural practices, post-harvesting treatment in relation to preserving preferred habitats, hunter harvest protection, and possibly habitat enhancement.

5. More information on LRH winter range characteristics are needed to implement logging plans. We therefore propose an additional study to assess in detail the habitat conditions affecting the LRH. Study design should use snow depth and caribou distribution criteria (delineation of specific habitats preferred by caribou), compared to ground work on the distribution of lichens, to quantify the amount of useable winter range to be affected by logging.

PERSONAL COMMUNICATIONS

Dickson Lutz, Chief of the Liard Indian Band, Watson Lake, Yukon.

Doug Steventon, Wildlife Management Biologist, B.C. Fish and Wildlife Branch, Smithers, B.C.

Peter Stone, Former Chief of the Lower Post Indian Band, Lower Post, B.C.

John Russell, Watson Lake District Conservation Officer, Watson Lake, Yukon.

Barry Tokarek, Former Watson Lake District Conservation Officer, Prince George, B.C.

Ray Quock, Native Harvest Biologist, Yukon Fish and Wildlife Branch, Whitehorse, Yukon

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APPENDICES

Appendix A. Summary of surveys flown to inventory the Little Rancheria herd.

	Date	Survey Type	Caribou Season	Objective
1.	85-02-21 85-02-24	Helicopter (9.5 hrs.)	Late Winter	a. Capture and radio-collar five caribou. b. Snow distribution survey.
2.	85-06-03	Fixed Wing (3.5 hrs.)	Calving	a. Relocate radio-collars. b. Determine calving distribution.
3.	85-07-20	Fixed Wing (3.2 hrs.)	Post-calving	a. Relocate radio-collars. b. Determine calving distribution.
	85-07-21	Helicopter (5.1 hrs.)		a. Composition count. b. Distribution details.
	85-07-23	Helicopter (3.5 hrs.)		a. Capture and radio-collar one caribou. b. Investigate mortality.
4.	85-10-03	Fixed Wing (1.5 hrs.)	Rut	a. Relocate radio-collars. b. Determine rut distribution.
	85-10-05	Helicopter (3.0 hrs.)		a. Composition count. b. Distribution details.
5.	86-02-02	Fixed Wing (1.5 hrs.)	Late Winter	a. Relocate radio-collars. b. Determine winter distribution.
	86-02-03 86-02-04 86-02-05 86-02-06	Helicopter (12 hrs.)		a. Capture and radio-collar five caribou. b. Distribution details. c. Reconnaissance for Swan Lake herd winter range.

Appendix A. (continued)

6.	86-06-03	Fixed Wing (2.6 hrs.)	Calving	a. Relocate radio-collars. b. Determine calving distribution.
7.	86-07-17	Fixed Wing (2.8 hrs.)	Post-calving	a. Relocate radio-collars. b. Determine post-calving distribution.
	86-07-19	Helicopter (5.1 hrs.)		a. Composition count. b. Distribution details. c. Investigate two mortalities.
8.	86-10-09	Fixed Wing (2.5 hrs.)	Rut	a. Relocate radio-collars. b. Determine rut distribution.
	86-10-10	Helicopter (5.8 hrs.)		a. Composition count. b. Distribution details.
9.	87-02-10	Fixed Wing (2.5 hrs.)	Late Winter	a. Relocate radio-collars. b. Determine winter distribution.
10.	88-03-27 to 88-04-01	Fixed Wing (20 hrs.) Helicopter (32 hrs.)	Late Winter	a. Relocate radio-collars. b. Delineate survey area for census. c. Stratification survey. d. Census survey.
	88-04-02	Helicopter (3.0 hrs.)		a. Snow distribution survey. b. Fecal sample collection.

APPENDIX B
The data for all relocations by radio-collar

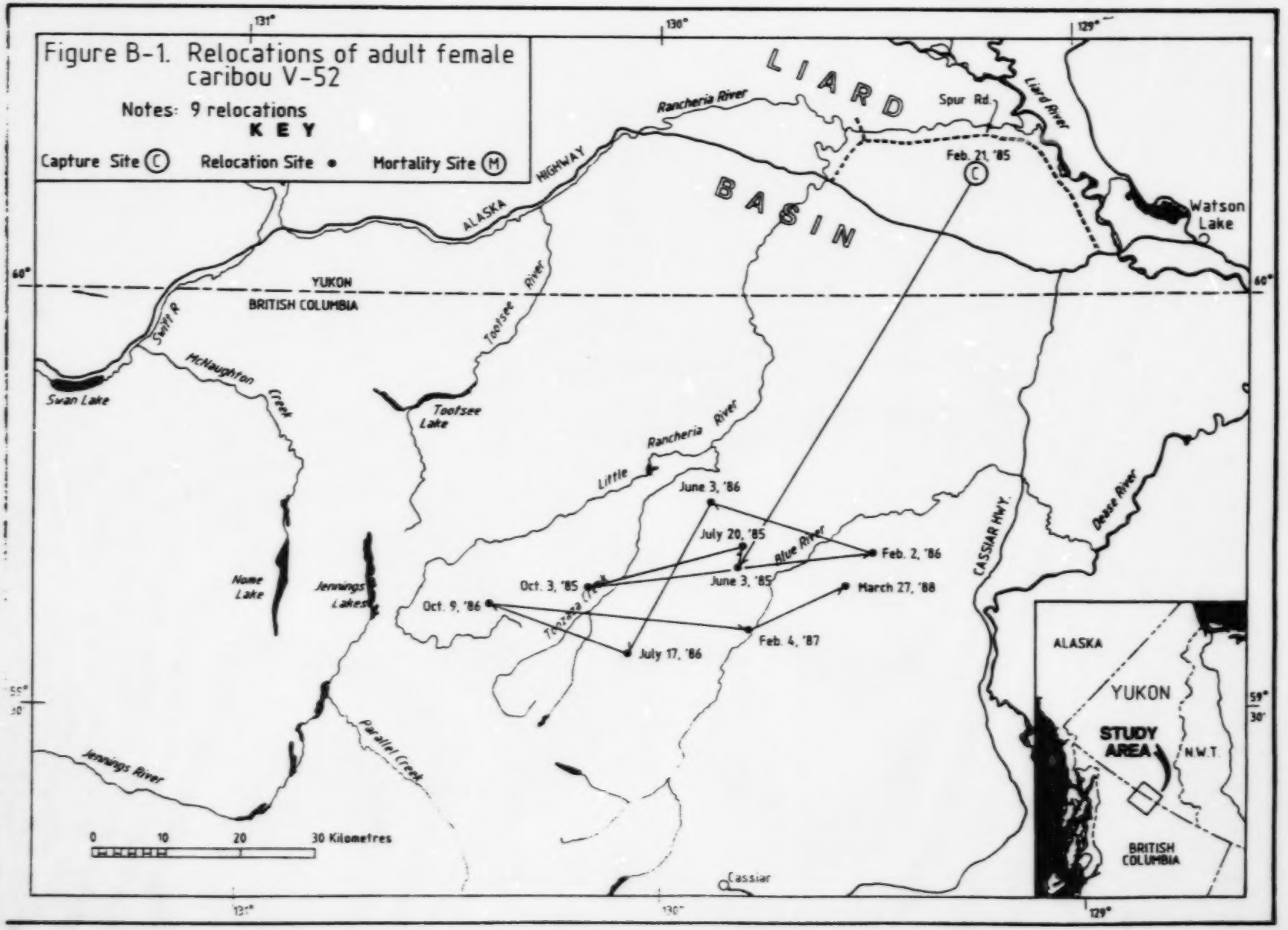
Figure B-1. Relocations of adult female caribou V-52
Notes: 9 relocations
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
LIARD
BASIN
Rancheria River
Spur Rd.
Liard River
Feb. 21, '85
Watson Lake
ALASKA HIGHWAY
60°
YUKON
BRITISH COLUMBIA
Swift R
Toolsee River
McNaughton Creek
Swan Lake
Toolsee Lake
Rancheria River
Little
June 3, '86
July 20, '85
Blue River
Feb. 2, '86
June 3, '85
Oct. 3, '85
March 27, '88
Oct. 9, '86
Feb. 4, '87
July 17, '86
Nome Lake
Jennings Lakes
CASSIAR HWY.
Dease River
Parallel Creek
Jennings River
55°
30'
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA
59°
30'

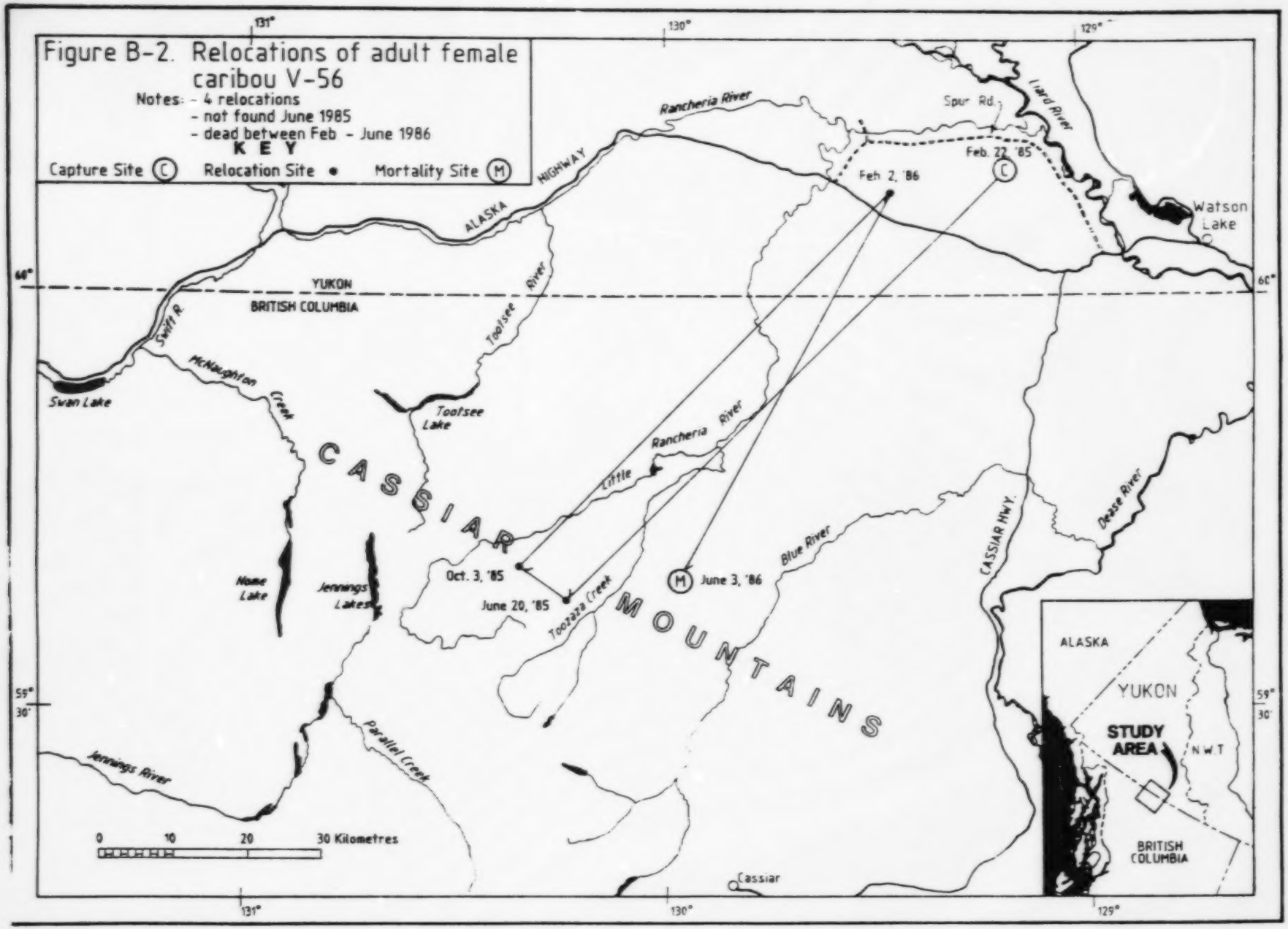
Figure B-2. Relocations of adult female caribou V-56
Notes: - 4 relocations
- not found June 1985
- dead between Feb - June 1986
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
60°
55° 30'
Rancheria River
Spur Rd.
Liard River
HIGHWAY
ALASKA
Feb. 22, '85
Feb 2, '86
Watson Lake
YUKON
BRITISH COLUMBIA
Swift R.
Toolsee River
McNaughton Creek
Swan Lake
Tootsee Lake
Rancheria River
Little
CASSIAR MOUNTAINS
Oct. 3, '85
June 20, '85
June 3, '86
Blue River
CASSIAR HWY.
Dease River
Home Lake
Jennings Lakes
Toodaza Creek
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T
BRITISH COLUMBIA

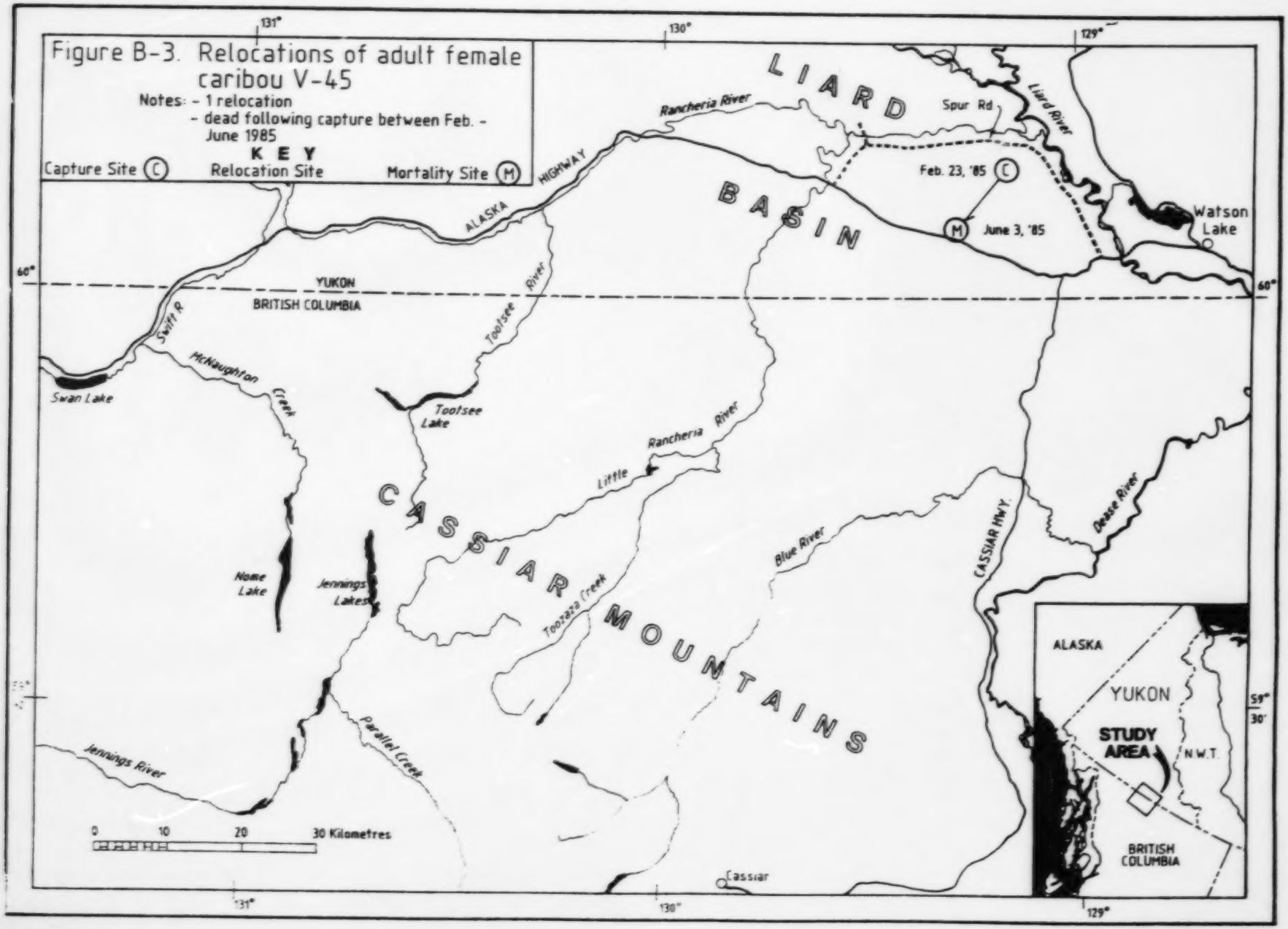
Figure B-3. Relocations of adult female caribou V-45
Notes: - 1 relocation
- dead following capture between Feb. - June 1985
KEY
Capture Site (C)
Relocation Site
Mortality Site (M)
131°
130°
129°
60°
59° 30'
LIARD
BASIN
CASSIAR MOUNTAINS
Rancheria River
Spur Rd
Liard River
HIGHWAY
ALASKA
Feb. 23, '85
June 3, '85
Watson Lake
YUKON
BRITISH COLUMBIA
Swift R
Toolsee River
McNaughton Creek
Swan Lake
Toolsee Lake
Little Rancheria River
Name Lake
Jennings Lakes
Toozaza Creek
Blue River
CASSIAR HWY.
Dease River
Jennings River
Parallel Creek
Cassiar
0 10 20 30 Kilometres
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA

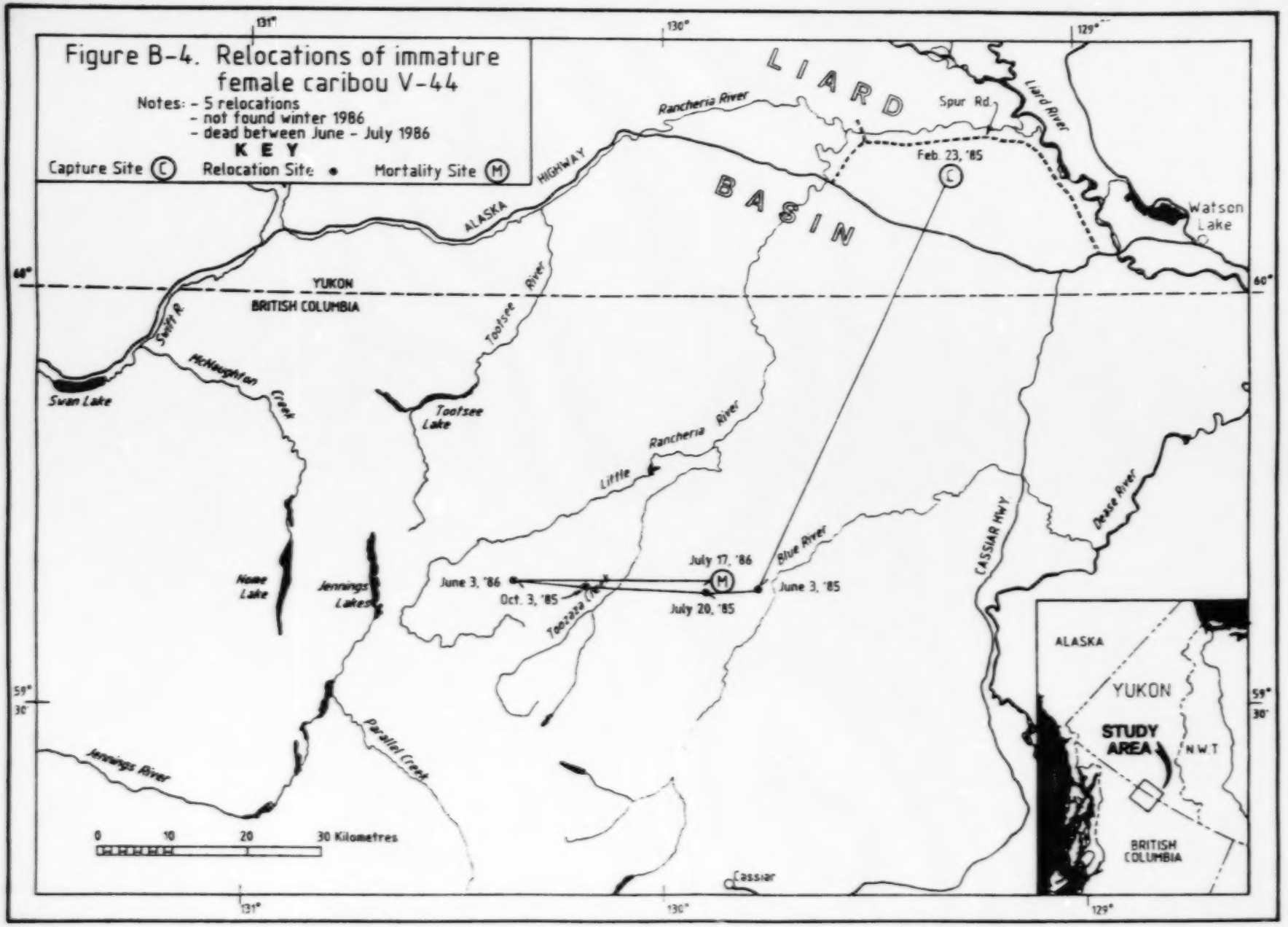
Figure B-4. Relocations of immature female caribou V-44
Notes: - 5 relocations
- not found winter 1986
- dead between June - July 1986
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
LIARD
BASIN
Rancheria River
Spur Rd.
Liard River
Feb. 23, '85
HIGHWAY
ALASKA
Watson Lake
60°
YUKON
BRITISH COLUMBIA
Swift R.
Tootsee River
McNaughton Creek
Swan Lake
Tootsee Lake
Rancheria River
Little
Dease River
CASSIAR HWY
Blue River
July 17, '86
June 3, '86
June 3, '85
Oct. 3, '85
July 20, '85
Nome Lake
Jennings Lakes
59° 30'
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA

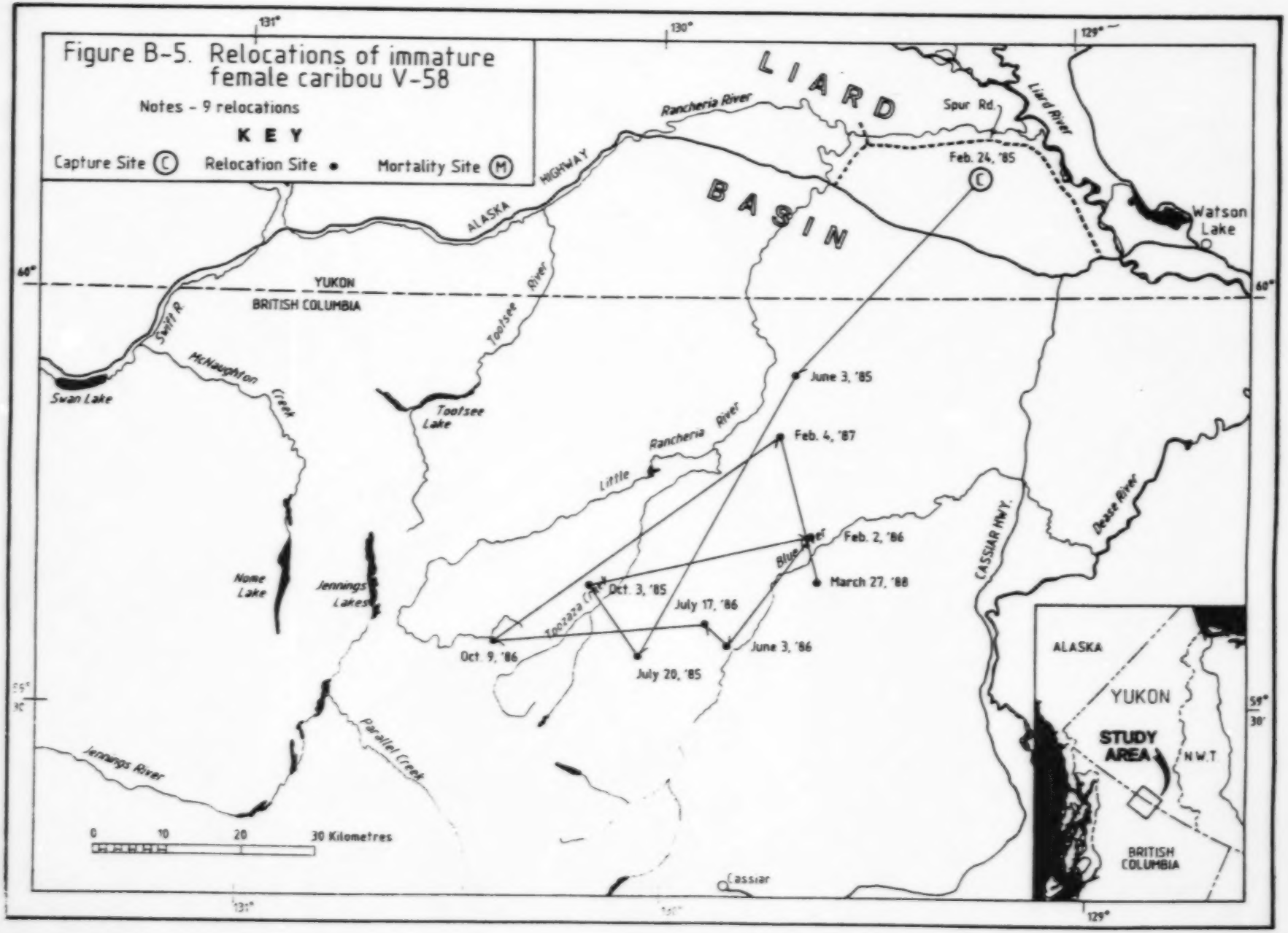
Figure B-5. Relocations of immature female caribou V-58
Notes - 9 relocations
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
LIARD
BASIN
Rancheria River
Spur Rd.
Liard River
Feb. 24, '85
ALASKA HIGHWAY
Watson Lake
60°
YUKON
BRITISH COLUMBIA
Swift R.
Toodsee River
McHaughton Creek
Swan Lake
Toodsee Lake
June 3, '85
Rancheria River
Feb. 4, '87
Little
Blue
Feb. 2, '86
March 27, '88
CASSIAR HWY.
Dease River
Nome Lake
Jennings Lakes
Oct. 3, '85
July 17, '86
Oct. 9, '86
June 3, '86
July 20, '85
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA
59° 30'

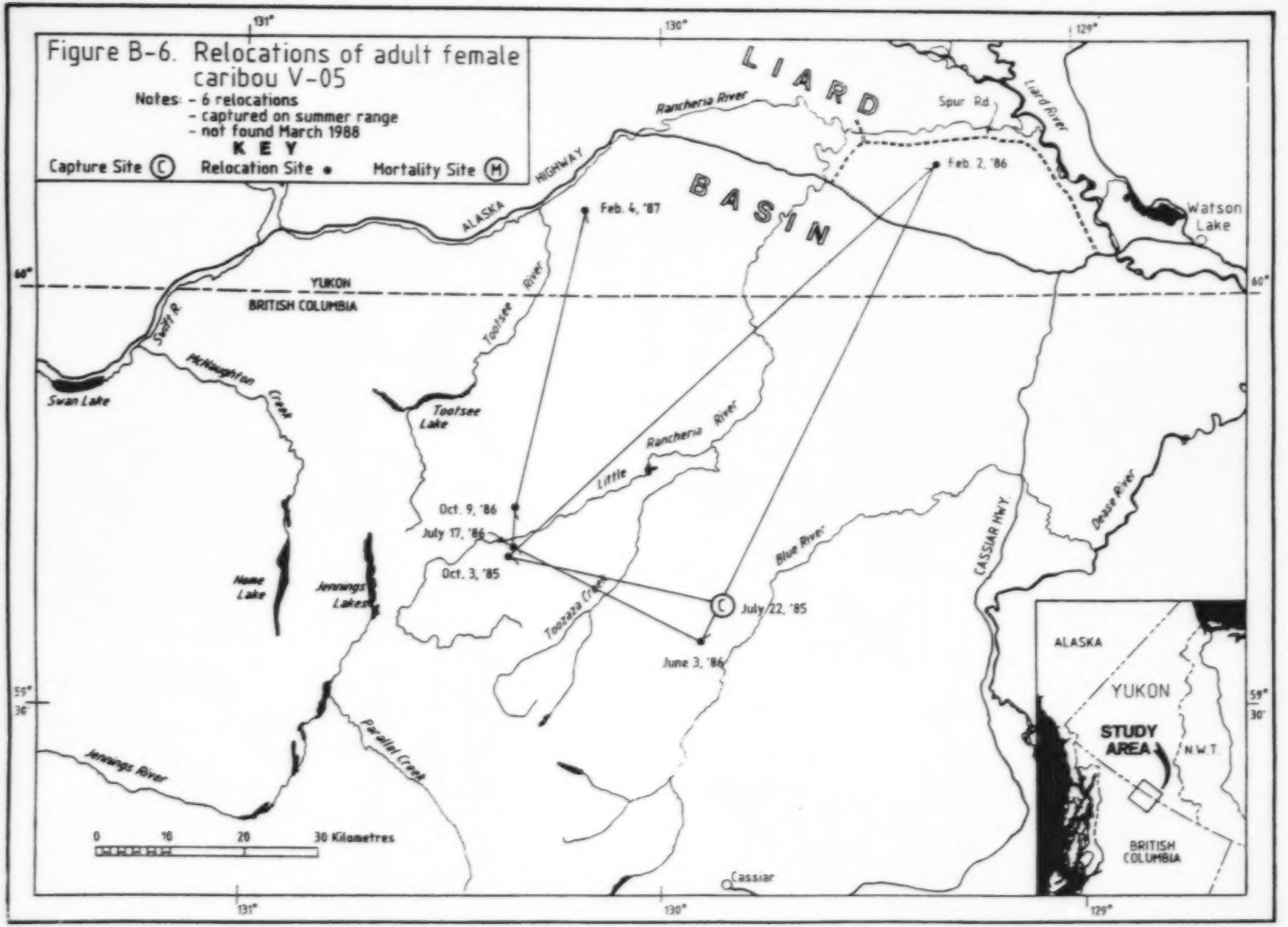
Figure B-6. Relocations of adult female caribou V-05
Notes: - 6 relocations
- captured on summer range
- not found March 1988
KEY
Capture Site C Relocation Site • Mortality Site M
131°
130°
129°
LIARD
BASIN
Rancheria River
Spur Rd.
Liard River
HIGHWAY
ALASKA
Feb. 4, '87
Feb. 2, '86
Watson Lake
60°
YUKON
BRITISH COLUMBIA
Swift R.
Toolsee River
McNaughton Creek
Swan Lake
Toolsee Lake
Rancheria River
Little
Oct. 9, '86
July 17, '86
Oct. 3, '85
Name Lake
Jennings Lakes
Toozaza Creek
July 22, '85
June 3, '86
Blue River
CASSIAR HWY
Dease River
55° 30'
59° 30'
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA

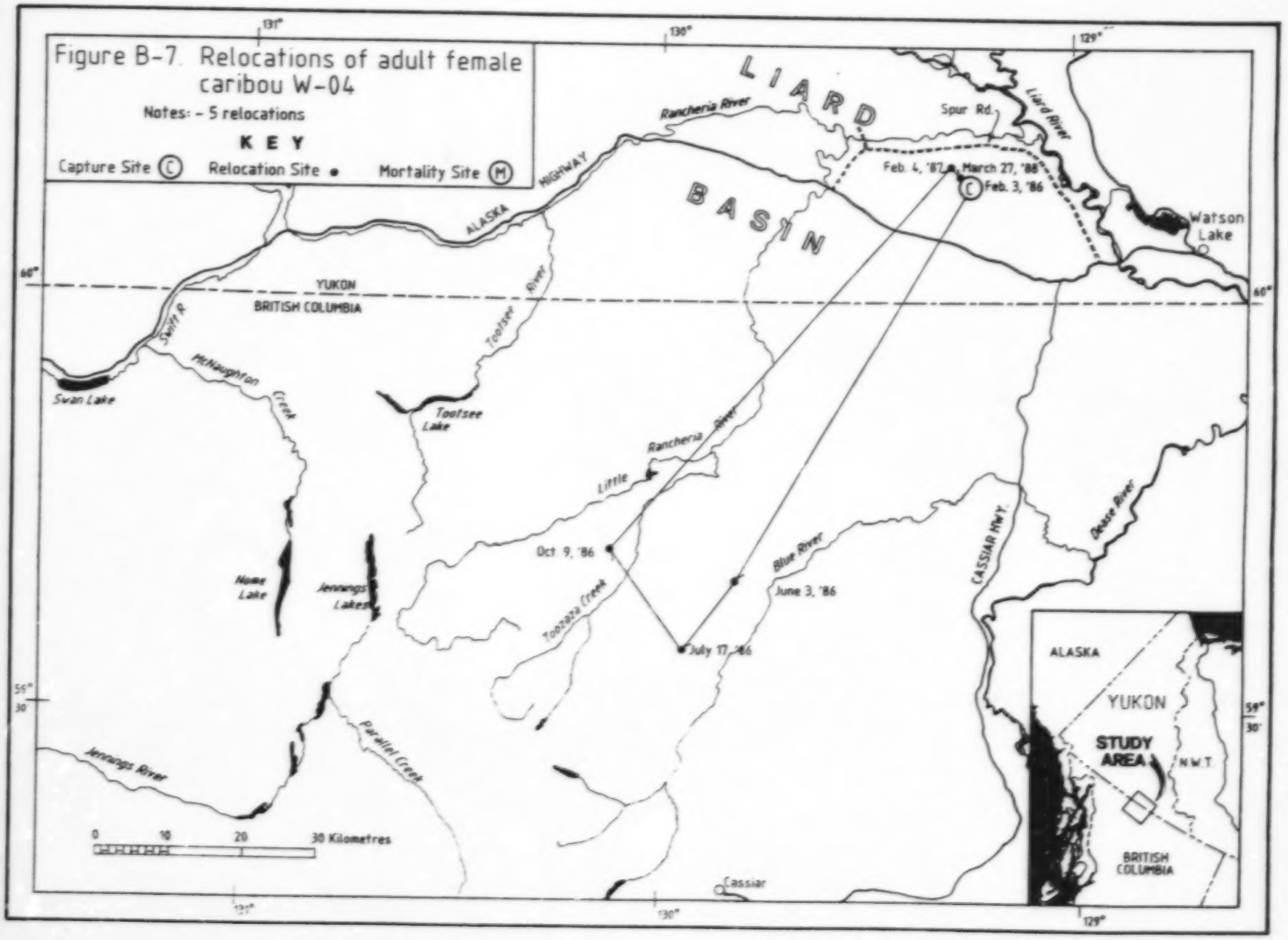
Figure B-7. Relocations of adult female caribou W-04
Notes: - 5 relocations
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
LIARD
BASIN
Rancheria River
Liard River
Spur Rd.
Feb. 4, '87 - March 27, '88
Feb. 3, '86
Watson Lake
ALASKA HIGHWAY
60°
YUKON
BRITISH COLUMBIA
Swift R.
Toolsee River
McNaughton Creek
Swan Lake
Toolsee Lake
Rancheria River
Little
Oct. 9, '86
Blue River
June 3, '86
CASSIAR HWY.
Dease River
Nome Lake
Jennings Lakes
Toozaza Creek
July 17, '86
55° 30'
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA
59° 30'

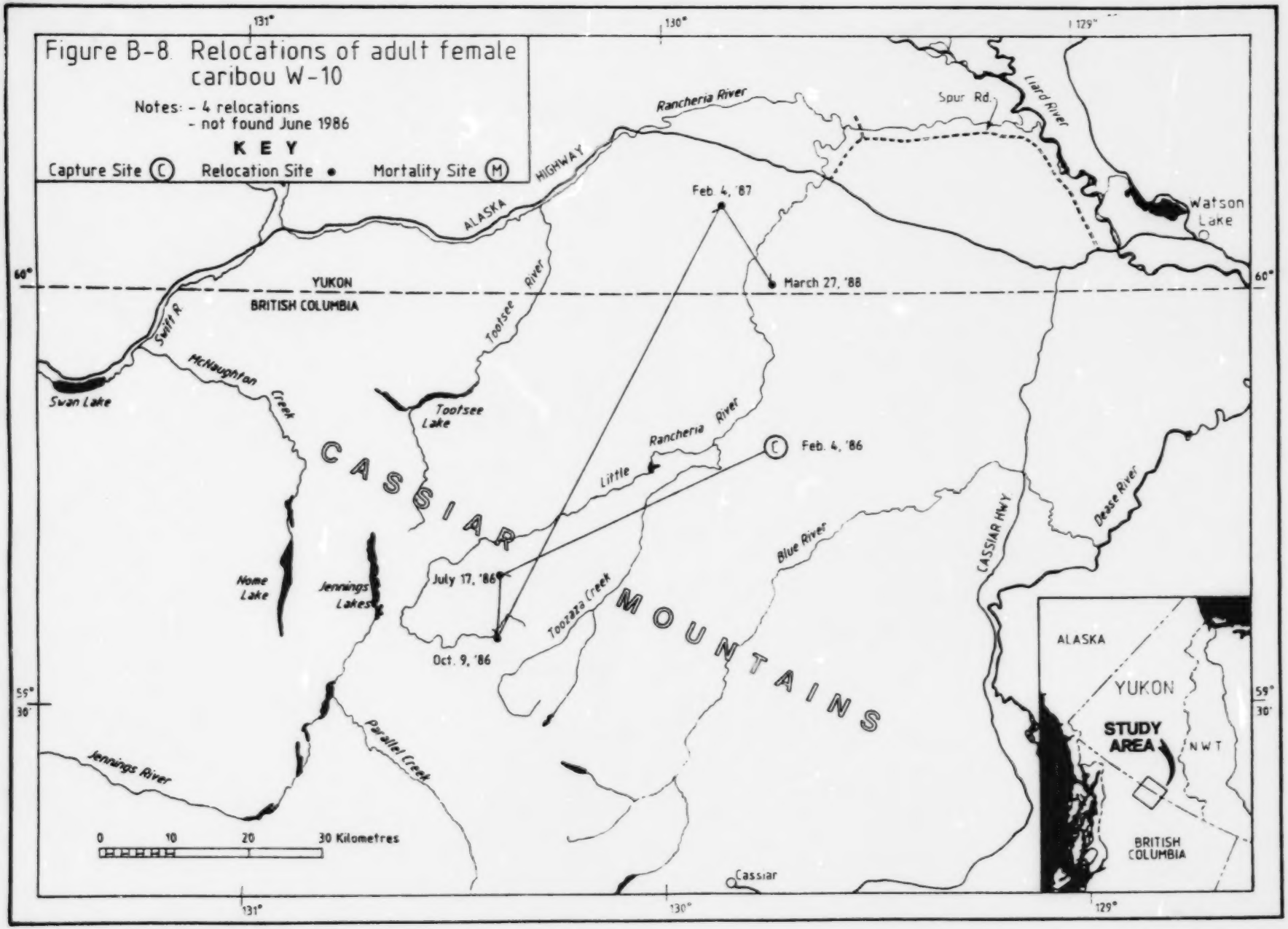
Figure B-8 Relocations of adult female caribou W-10
Notes: - 4 relocations
- not found June 1986
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
60°
59° 30'
Rancheria River
Spur Rd.
Liard River
HIGHWAY
ALASKA
Feb. 4, '87
Watson Lake
March 27, '88
YUKON
BRITISH COLUMBIA
Swift R.
McNaughton Creek
Swan Lake
Tootsee River
Tootsee Lake
Rancheria River
Feb. 4, '86
Little
CASSIAR MOUNTAINS
Nome Lake
Jennings Lakes
July 17, '86
Oct. 9, '86
Toozaza Creek
Blue River
CASSIAR HWY
Dease River
Jennings River
Parallel Creek
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
NWT
BRITISH COLUMBIA

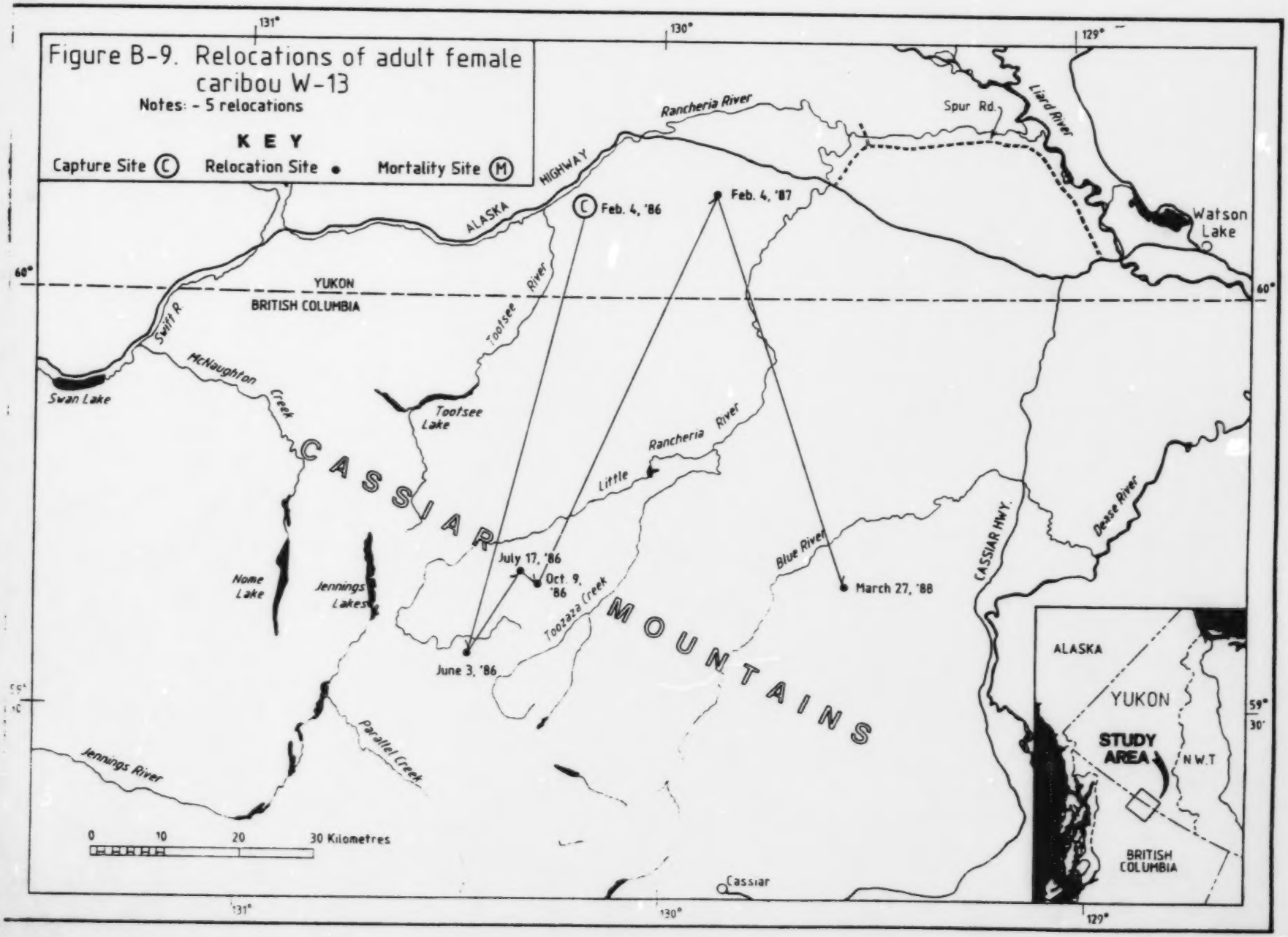
Figure B-9. Relocations of adult female caribou W-13
Notes: - 5 relocations
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
Rancheria River
Spur Rd.
Liard River
HIGHWAY
ALASKA
Feb. 4, '86
Feb. 4, '87
Watson Lake
60°
YUKON
BRITISH COLUMBIA
Swift R.
Toolsee River
McNaughton Creek
Swan Lake
Tootsee Lake
CASSIAR MOUNTAINS
Little Rancheria River
Dease River
CASSIAR HWY.
July 17, '86
Oct. 9, '86
Nome Lake
Jennings Lakes
Toozaza Creek
Blue River
March 27, '88
June 3, '86
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T
BRITISH COLUMBIA
59° 30'

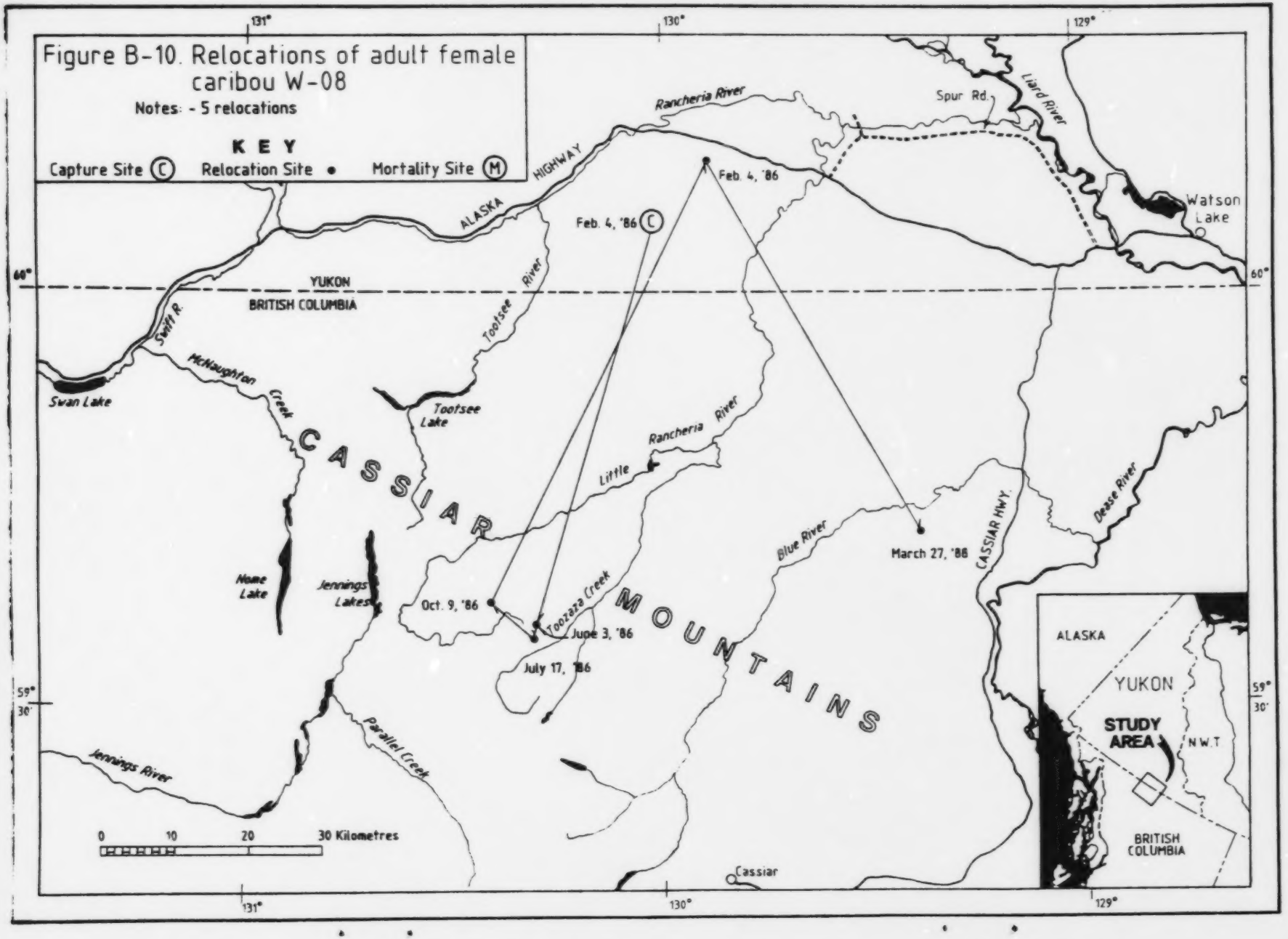
Figure B-10. Relocations of adult female caribou W-08
Notes: - 5 relocations
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
60°
59° 30'
Rancheria River
Spur Rd.
Liard River
HIGHWAY
ALASKA
Feb. 4, '86
Feb. 4, '86 (C)
Watson Lake
YUKON
BRITISH COLUMBIA
Swift R.
McNaughton Creek
Swan Lake
Tootsee River
Tootsee Lake
Rancheria River
Little
CASSIAR MOUNTAINS
March 27, '86
CASSIAR HWY.
Dease River
Blue River
Home Lake
Jennings Lakes
Oct. 9, '86
Toozaza Creek
June 3, '86
July 17, '86
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA

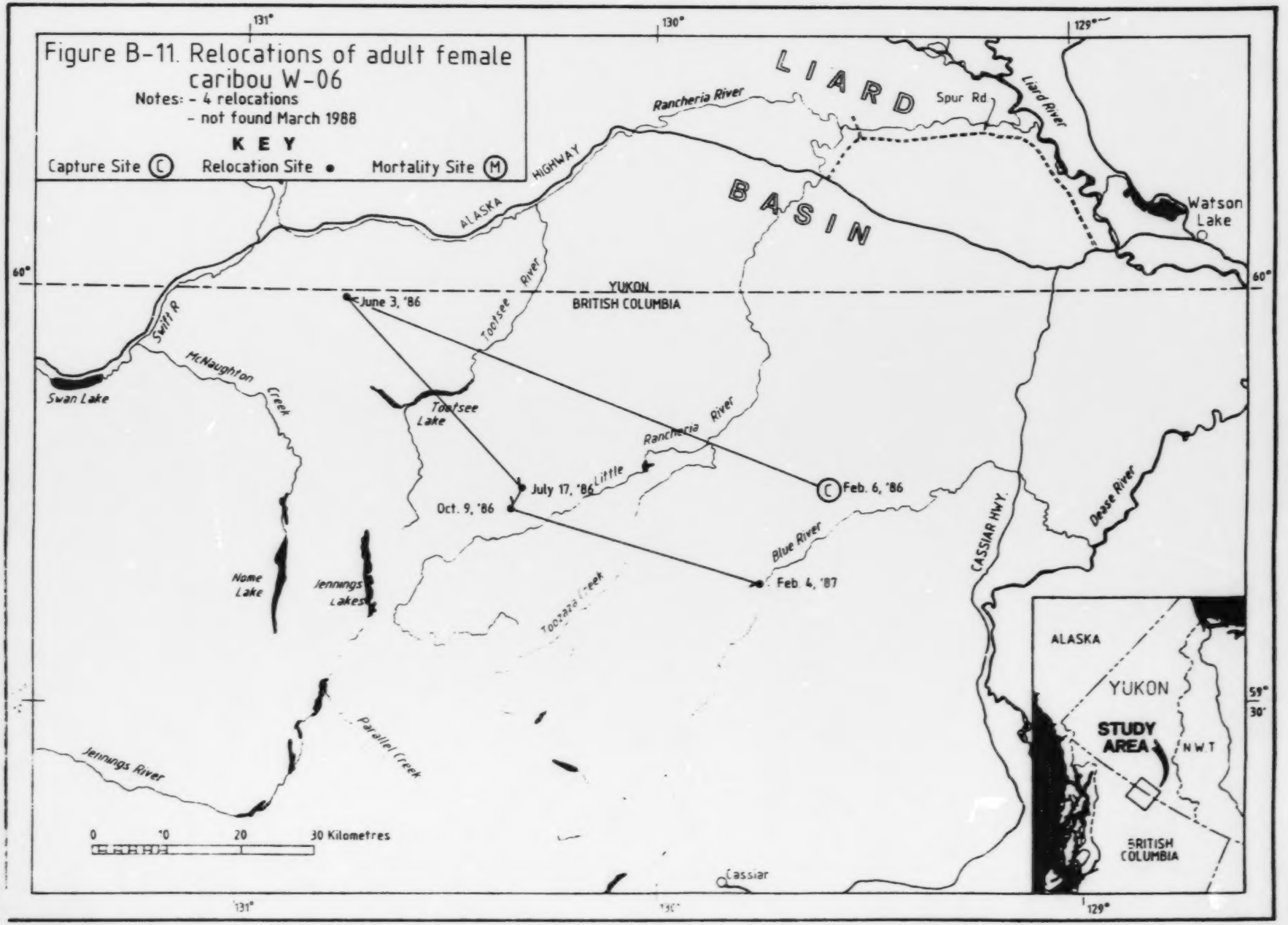
Figure B-11. Relocations of adult female caribou W-06
Notes: - 4 relocations
- not found March 1988
KEY
Capture Site (C) Relocation Site • Mortality Site (M)
131°
130°
129°
LIARD
Rancheria River
Spur Rd
Liard River
HIGHWAY
ALASKA
BASIN
Watson Lake
60°
YUKON
BRITISH COLUMBIA
June 3, '86
Toolsee River
Swift R
McNaughton Creek
Swan Lake
Toolsee Lake
Rancheria River
July 17, '86
Little
Oct. 9, '86
(C) Feb. 6, '86
Dease River
CASSIAR HWY.
Blue River
Feb. 4, '87
Nome Lake
Jennings Lakes
Toozaza Creek
Parallel Creek
Jennings River
0 10 20 30 Kilometres
Cassiar
ALASKA
YUKON
STUDY AREA
N.W.T.
BRITISH COLUMBIA
59° 30'

Appendix C. Caribou survey data for the Little Rancheria caribou herd population estimate, 27 March to 1 April, 1988.

Low Intensity Search 2.36 min/km^2 = (6 min/mi^2)

#	Date	Survey Unit	Adult Cow	Calf	Immature Male	Mature Male	Unclass	Total	Area	Time
Primary Strata										
1	3/29	27	-	-	-	-	-	0	13.2	53
2	3/29	40	15	1	6	1	2	27	27.5	78
3	3/29	38	30	3	2	3	2	40	21.7	89
4	3/29	12	64	16	9	-	-	89	30.9	88
5	3/29	20	7	4	1	11	-	23	36.8	74
6	3/29	18	-	-	-	-	-	0	36.7	71
7	3/30	39	3	-	-	-	1	4	26.1	61
8	3/30	26	1	2	1	-	1	5	16.1	45
Totals			120	26	19	15	6	187	209	559
Secondary Strata										
1	3/29	45	1	1	-	-	-	2	38.3	76
2	3/30	44	13	2	1	2	-	18	42.3	83
3	3/30	14	7	6	-	-	-	13	17.3	33
4	3/30	8	7	4	-	-	-	11	31.6	68
5	3/30	34	8	2	4	1	2	17	19.9	57
6	3/30	28	9	3	3	1	2	18	14.7	47
7	3/31	10	3	4	-	-	-	7	30.5	56
8	3/31	15	-	-	-	-	-	0	29.4	64
9	4/01	4	11	3	2	1	-	17	32.4	77
10	4/01	1	-	-	-	-	-	0	22.2	29
11	4/01	9	9	2	-	-	-	11	17.6	41
12	4/01	19	7	3	2	7	-	19	37.3	75
13	4/01	46	-	-	-	-	-	0	16.0	23
14	4/01	16	6	-	-	1	-	7	22.6	62
15	4/01	17	-	-	-	-	-	0	22.2	60
16	4/01	41	5	1	2	-	1	9	17.2	53
17	4/01	42	2	-	-	-	1	3	18.9	49
Totals			88	31	14	13	12	152	430.4	953
Grand Totals			208	57	33	28	12	339	639.4	1512

Appendix C. (continued)

High Intensity Search 6.1 min/km^2 = (15.8 min/mi^2)

Number	Area (km^2)	Time	Intensity Over Survey Count	S.C.F.[a]
1	4.0	24	42/28	1.50
2	3.9	17	4/4	1.00
3	2.8	18	10/10	1.00
4	4.6	31	10/8	1.25
5	4.3	37	12/7	1.71
6	4.5	21	10/9	1.11
Totals	24.1	148	--	$\bar{X}$ = 1.357[b]

a. Sightability Correction Factor

b. calculated by HP-97 formula developed by Gasaway et al. 1986

Appendix D. Composition of the Little Rancheria caribou herd from post-calving and fall surveys, 1985 and 1986.

Year	Season	Females	Calves	Yearlings	Males	Total
			Count			
1985	July	115	47	19	17	151
1985	October	145	41	15	43	244
1986	July	170	47	25	25	267
1986	October	233	65	-	75	373
			Percentages			
1985	July	58	24	9	9	-
1985	October	59	17	6	18	-
1986	July	64	18	9	9	-
1986	October	63	17	-	20	-
			Ratios (per 100 females)			
1985	July	-	41	17	15	-
1985	October	-	28	10	30	-
1986	July	-	28	15	15	-
1986	October	-	28	-	32	-

Appendix E. Percent (± SD) of discerned plant fragments in fecal samples collected during winter on the range of the Little Rancheria caribou herd, 1985 to 1988.

Plant genus or group	1985 Sample 1		1985 Sample 2		1986 Sample 1		1986 Sample 2		1987 Sample 1		1988 Sample 1		1988 Sample 2	
Moss	---		---		3.78		2.61		0.37		1.03		3.64	
					3.78	(1.68)	2.61	(2.60)	0.37	(0.82)	1.03	(0.96)	3.64	(3.60)
Fruticose Lichens	88.20		84.96		67.71		54.95		73.49		89.45		58.91	
(Terrestrial)														
Cetraria-type	2.97	(1.37)	2.32	(2.26)	6.05	(4.77)	4.35	(1.72)	3.26	(2.99)	3.71	(4.05)	3.68	(3.69)
Cladonia-type	85.23	(3.66)	82.64	(7.03)	61.66	(10.30)	50.60	(8.87)	70.23	(6.82)	83.65	(6.88)	55.23	(14.43)
(Arboreal)														
Alectoria											1.72	(1.82)		
Usnea											0.37	(0.83)		
Foliose Lichens	0.39		---		4.49		3.27		2.06		---		---	
(Peltigera)	0.39	(0.86)			4.49	(3.63)	3.27	(2.29)	2.06	(2.20)				
Horsetails	---		5.72		9.23		1.26		5.44		0.37		2.99	
(Equisetum)			5.72	(2.29)	9.23	(7.44)	1.26	(2.81)	5.44	(3.77)	0.37	(0.83)	2.99	(2.39)
Graminoids	1.21		0.48		3.18		28.38		5.54		1.78		1.22	
Carex	0.83	(1.15)	0.48	(1.06)	3.18	(3.03)	27.12	(7.28)	5.54	(3.33)	0.75	(1.09)		
Festuca							1.26	(2.81)			1.03	(1.50)	0.61	(1.37)
Unknown grass	0.38	(0.86)												
Unknown sedge													0.61	(1.37)
Evergreen Shrubs	10.20		8.84		10.98		8.43		12.73		7.10		31.99	
Ledum	1.99	(1.90)	0.85	(1.18)	5.06	(5.44)	3.09	(0.57)			2.31	(2.18)	16.44	(10.21)
Picea			0.42	(0.93)	3.36	(1.84)	1.10	(1.53)	0.35	(0.79)	1.54	(1.68)		
Vaccinium	0.35	(0.79)	0.42	(0.93)										
Cassiope					0.51	(1.14)								
Pinus	7.86	(3.82)	7.15	(6.20)	1.42	(1.31)	4.24	(2.53)	12.38	(6.72)	2.66	(1.94)	15.55	(8.88)
Empetrum					0.63	(1.41)					0.32	(0.72)		
Unknown Ericaceae											0.27	(0.61)		
Forbs	---		---		0.63		1.10		0.37		0.27		1.25	
Lupinus					0.63	(1.41)	1.10	(1.53)	0.37	(0.82)	0.27	(0.61)	0.61	(1.37)
Astragalus													0.64	(1.43)
Total Lichens	88.59		84.96		72.20		58.22		75.55		89.45		58.91	